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RESEARCH ARTICLE

Measurement in the nominal and verbal domains

Kimiko Nakanishi

Abstract This paper examines some aspects of the grammar of measurement based on data from non-split and split measure phrase (MP) constructions in Japanese. I claim that the non-split MP construction involves measurement of individuals, while the split MP construction involves measurement of events as well as of individuals. This claim is based on the observation that, while both constructions are subject to some semantic restrictions in the nominal domain, only the split MP construction is sensitive to restrictions in the verbal domain (namely, incompatibility with single-occurrence events and with individual-level predicates, and (un)availability of collective readings). It is shown that these semantic restrictions can be explained by a uniform semantic constraint on the measure function, namely, Schwarzschild's [(2002). The grammar of measurement. *The Proceedings of Semantics and Linguistics Theory, 24*, 241–306] monotonicity constraint. In particular, I argue that, in the two constructions at issue, the measure function is subject to the monotonicity constraint, and that we observe different semantic restrictions depending on whether the measure function applies to a nominal or a verbal domain.

Keywords Measure phrases · Numerals · Split quantifiers · Events · Lattices · Distributivity · Plurality

1 Issues

Languages are equipped with expressions indicating amount in noun phrases. For instance, in *three students*, the number of students is indicated by the numeral *three* and, in *three liters of water*, the measure phrase *three liters*

K. Nakanishi (✉)
Department of Linguistics, University of Calgary,
Calgary, Alberta, Canada T2NIN4
e-mail: k.nakanishi@ucalgary.ca

indicates the amount of water. Languages can also express measurement of verbal predicates: *for three hours* in *John slept for three hours* indicates how long John slept, and *three miles* in *John ran three miles* indicates how far John ran. The aim for this paper is to examine measurement in the nominal and verbal domains and to provide a systematic mechanism of measurement. The empirical data come from the so-called floating quantifier construction in Japanese and its non-floating counterpart, exemplified in (1) and (2).

(1)a.	[**Gakusei**	**san-nin**]-ga	ie-ni	kaet-ta	(koto)[1]
	[student	three-CL]-NOM	home-to	go-PAST	(the fact that)
	'Three students went home.'				
b.	**Gakusei**-ga	ie-ni	**san-nin**	kaet-ta	(koto)
	student-NOM	home-to	three-CL	go-PAST	

(2)a.	[**Mizu**	**san-rittoru**]-ga	tukue-nouede	kobore-ta	(koto)
	[water	three-liter]-NOM	table-on	spill-PAST	
	'Three liters of water spilled on the table.'				
b.	**Mizu**-ga	tukue-nouede	**san-rittoru**	kobore-ta	(koto)
	water-NOM	table-on	three-liter	spill-PAST	

These examples show that numerals in Japanese must be followed by a classifier, yielding a classifier phrase (*san-nin* 'three-CL' in (1)), or by a measure word, yielding a measure phrase (*san-rittoru* 'three liters' in (2)).[2] In the following, the term measure phrases (MPs) refers to both classifier phrases and genuine measure phrases. In (1a) and (2a), the MPs express amount in the adjacent noun phrase. These MPs are addressed as non-split MPs and the sentences involving non-split MPs are called non-split MP constructions.[3] We could assume that, in the non-split MP construction, the MP syntactically combines with a noun phrase and semantically expresses measurement of individuals denoted by the noun phrase, satisfying a general assumption of compositionality that semantic rules apply in accord with syntactic rules. However, the situation is more complex given the examples in (1b) and (2b), where the MPs

[1] Matrix sentences in Japanese are subject to some pragmatic restrictions, while such restrictions do not occur in embedded clauses. Throughout the paper, *koto* 'the fact that' is added to create an embedded environment.

[2] A classifier is a morpheme that indicates the semantic class of a relevant noun phrase in terms of shape, size, animacy, etc. (see Downing 1996 for details on Japanese classifiers).

[3] There is another construction where an MP is adjacent to a measured noun phrase, which is exemplified in (i). This construction is not examined here, since it does not show semantic restrictions relevant to this paper.

(i)	[**San-nin**-no	**gakusei**]-ga	ie-ni	kaet-ta (koto)
	[three-CL-GEN	student]-NOM	home-to	go-PAST

are not adjacent to a noun phrase. These MPs and the sentences containing them are called split MPs and split MP constructions, respectively.[4] Unlike the non-split MPs in (1a) and (2a), the split MPs in (1b) and (2b) do not form a nominal constituent with a nominal predicate on the surface, yet the classifier *-nin* in (1b) and the measure word *-rittoru* 'liter' in (2b) indicate some connection with *gakusei* 'student' and with *mizu* 'water', respectively. I use the term host NP to refer to the noun phrase that non-split and split MPs are semantically associated with. A natural question arises whether a split MP expresses measurement in the nominal domain in the same way as its non-split counterpart.

In this paper, I claim that non-split and split MP constructions differ in their domains of measurement: the non-split MP construction involves the measurement of individuals and the split MP construction involves the measurement of events as well as of individuals. This claim is based on the observation that, while both constructions are subject to some semantic restriction in the nominal domain, only the split MP construction is sensitive to restrictions in the verbal domain. It is shown that these semantic restrictions can be explained by a uniform semantic constraint on the measure function, namely, Schwarzschild's (2002) monotonicity constraint. In particular, I argue that, in the two constructions at issue, the measure function is subject to the monotonicity constraint, and that we observe different semantic restrictions depending on whether the measure function applies to a nominal or a verbal domain. I further argue that the mechanism of event measurement requires a semantic mapping from events to individuals, and thus the measure function may apply to individuals mapped from events. This mechanism enables us to satisfactorily account for at least three characteristic semantic properties of the split MP construction: (i) incompatibility with single-occurrence events, (ii) incompatibility with individual-level predicates, and (iii) (un)availability of collective readings. Moreover, the paper makes a strong case that event arguments exist in the grammar and that there is a semantic correlation between individuals in the nominal domain and events in the verbal domain.

The structure of the paper is as follows: Sect. 2 examines semantic properties of non-split and split MP constructions and argues that non-split MPs measure the individuals denoted by the host NP, whereas split MPs indirectly measure the events denoted by the VP by measuring individuals. A semantic mechanism is proposed to account for the fact that the split MP is associated both with nominal and with verbal predicates. Section 3 discusses the syntax and compositional semantics of the two constructions. In the syntax, a non-split MP combines with a nominal predicate, while a split MP combines with a verbal predicate. Based on these structures, it is shown that the semantics of the two constructions can be compositionally derived. Section 4 concludes the paper

[4] The MPs in (1b) and (2b) are generally called floating quantifiers. Instead, I use the term "split MPs", since the analysis proposed for (1b) and (2b) in this paper extends to MPs in other languages that are not referred to as floating quantifiers, such as MPs in German Split NP Topicalization (Sect. 4; see Nakanishi 2004a, 2007 for details).

and discusses further cross-linguistic issues, including some discussion on split constructions in other languages.

2 Monotonicity as a formal property of measurement constructions

The empirical question to be investigated is this: do non-split and split MP constructions differ in terms of their domains of measurement? I argue that the answer to this question is positive by examining semantic properties of the two constructions. More specifically, I show that, although the two constructions are subject to the same semantic restrictions in the nominal domain, they behave differently in terms of some restrictions in the verbal domain.

2.1 Monotonicity in the nominal domain

This section examines some semantic restrictions on non-split and split MP constructions regarding the nominal measurement. I introduce Schwarzschild's (2002) analysis of English pseudopartitives, where we observe the same restriction as in Japanese. Naturally, Schwarzschild's analysis extends to the Japanese data.

2.1.1 The data and Schwarzschild's (2002) monotonicity constraint

We have seen in Sect. 1 that MPs such as *san-rittoru* 'three liters' can be used both in non-split and split MP constructions ((2) above). However, not all MPs can appear in the two constructions. For instance, the examples in (3) with *san-do* 'three degrees' are unacceptable. The question then is why there is such a restriction. To put it differently, what kind of restriction are we dealing with here?

(3)a.	*[**Mizu**	**san-do**]-ga	tukue-nouede	kobore-ta	(koto)
	[water	three-degree]-NOM	table-on	spill-PAST	

'Three degree water spilled on the table.'

b.	***Mizu**-ga	tukue-nouede	**san-do**	kobore-ta	(koto)
	water-NOM	table-on	three-degree	spill-PAST	

The same restriction is observed in Schwarzschild's (2002) work on pseudopartitives in English. To refer to water whose volume is three liters, English uses a pseudopartitive, as in *three liters of water*. However, the same construction cannot be used to express water whose temperature is three degrees, as in **three degrees of water*. Schwarzschild accounts for this restriction by examining how a measure function μ applies to a measured NP. For him, a measure function is a measurement scheme (e.g., volume, temperature, depth, etc.) obtained from a relation between an MP and the element to which the MP applies.[5] This is based on the observation that, in constructions involving measurement, the relevant measure function is determined by different factors such as world knowledge, context, etc. For instance, in *John bought five ounces of gold*, since *five ounces* specifies how much the relevant gold weighs, the measure function is 'weight'. It is 'length' in *John bought three feet of rope*, and 'depth' in *three feet of snow piled up*. In the following, under Schwarzschild's analysis, a measure function μ is indicated as μ: measurement scheme (e.g., μ: volume). Schwarzschild argues that the relation between a measure function and a measured NP is not uniform, as illustrated by the following comparison between μ: volume and μ: temperature. If a quantity of water has a certain volume, proper subparts of it will have lower volumes and superparts of it will have higher volumes. In this sense, μ: volume tracks part-whole relations. μ: temperature, however, does not, since if the water has a certain temperature, it is not necessarily true that proper subparts of it have lower temperatures or that superparts of it have higher temperatures. Schwarzschild calls a measure function monotonic relative to the denotation of some element iff it tracks part-whole structures of the element, that is, a measure obtained for that element is larger than a measure obtained for proper subparts of it, and is smaller than a measure obtained for proper superparts of it. I formulate this notion of monotonicity as in (4), where (4i) serves as a pre-condition for (4ii).

(4) A measure function μ is monotonic relative to domain I iff:

(i) there are two individuals x, y in I such that x is a proper subpart of y,[6] and

(ii) $\mu(x) < \mu(y)$

μ: volume is monotonic to the denotation of *water*, or ⟦*water*⟧ , while μ: temperature is non-monotonic to it. Schwarzschild captures the contrast between *three liters of water* and **three degrees of water* by claiming that the measure function in pseudopartitives must be monotonic relative to the part-whole structure given by the meaning of the noun phrase. Since μ: volume, but not μ:

[5] Schwarzschild's (2002) analysis departs from a standard analysis of MPs that a measure function is lexically denoted by a measure word (e.g., *liter* in *three liters of water*) and that the measure function is a function from individuals to numbers which preserve certain structures in the object domain (e.g., ⟦*three liters of water*⟧ = $\exists x[\text{water}(x) \wedge \text{liter}(x) = 3]$ (see Cartwright 1975; Krifka 1989, among others)). Schwarzschild makes this move, noting that the standard analysis of MPs is subject to the following three problems. First, the standard analysis does not extend to other occurrence of MPs such as *three feet longer*, *three feet away*, etc. Second, it faces a difficulty with examples without numerals, as in *several liters of water*. Presumably, the measure function denoted by *liter* maps an individual to a number denoted by *several*. However, *several* cannot be used in contexts where numbers are called for (e.g., **four plus several is less than ten*). Third, it cannot straightforwardly account for the plural agreement on measure words. See Schwarzschild (2002: 233) for details.

[6] I thank one of the reviewers for pointing out that the existential requirement must be included in the definition of monotonicity.

temperature, is monotonic to ⟦*water*⟧, *three liters of water* is acceptable, but not *three degrees of water*.[7] Schwarzschild provides the example *ten inches of oil* to support his analysis. This example may sound odd initially, since *oil* does not seem to be measured by *ten inches*. However, if we can find a measurement scheme which applies to ⟦*oil*⟧ in a monotonic fashion, the monotonicity account predicts this example to be acceptable. This prediction is borne out, as discussed in Schwarzschild (2002: 226). When there is a growing pool of oil seeping out of the ground, *oil* is measured by μ: diameter, hence *ten inches of oil* is acceptable.

Schwarzschild further shows that monotonicity can account for the contrast between *seven pounds of meat* and ??*seven pounds of baby*. *Meat* is a mass NP, and the extension of a mass NP has a part-whole relation; if you have a chunk of meat, any smaller chunk of that piece is still meat, and, if there are two chunks of meat, their sum is also meat. Thus, the measure function such as μ: weight can be monotonic relative to the denotation of mass NPs. In contrast, *baby* is a singular count NP, and the extension of a singular count NP is atomic, that is, it has nothing but a trivial part-whole relation. According to (4), for the measure function to be monotonic relative to some domain, there needs to be at least two members in the relevant domain that are in a part-whole relation. Thus, the measure function fails to be monotonic with respect to ⟦*baby*⟧. We could manipulate a part-whole structure by interpreting *baby* like *meat*, but that would evoke a gruesome interpretation. Schwarzschild further assumes that plural count NPs behave like mass NPs, since they come with a non-trivial part-whole structure given by the plural-part structure (e.g., if x and y are dogs, the sum of x and y are dogs as well). Thus, his analysis predicts that plural count NPs can be used in pseudopartitives just like mass NPs. Indeed, this prediction is borne out as is clear from examples like *four pounds of coffee beans* (but see footnote 9).[8]

In sum, Schwarzschild argues that pseudopartitives in English must satisfy what I call the monotonicity constraint on the nominal domain: the measure function μ must be monotonic relative to the part-whole structure given by the meaning of the host NP (the definition of monotonicity is given in (4)).

2.1.2 Extension to the Japanese data

As shown in (2) and (3), the Japanese non-split and split MP constructions show the same contrast as the English pseudopartitives with respect to different MPs

[7] See Krifka (1989) for an alternative analysis appealing to extensivity of measure functions. For Krifka, measure functions are lexically denoted by measure words and measure functions are functions from individuals to numbers (see footnote 5). In pseudopartitives, Krifka argues that measure functions must be extensive, satisfying additivity; if there are two objects whose weights are two ounces and three ounces, respectively, an extensive measure function yields five ounces. In *five ounces of gold*, the measure function *ounces* is extensive, while *carats* in **twenty carats of gold* is not (e.g., we cannot obtain twenty carats by adding five carats and fifteen carats).

[8] Schwarzschild's monotonicity analysis faces a serious problem with the numeral *one*; in *one dog*, which is fully acceptable, μ: cardinality cannot be monotonic to ⟦*dog*⟧, since ⟦*dog*⟧ does not come with a non-trivial part-whole structure. We may be able to dismiss this problem by adopting the claim that *one* is different from other numbers both syntactically and semantically (see, for instance, Borer 2005).

(*three liters* versus *three degrees*). To account for this contrast, I simply extend Schwarzschild's analysis to the Japanese data, and claim that the measure functions μ in the two Japanese constructions must obey the monotonicity constraint, that is, μ must be monotonic relative to the part-whole structure of the host NP. The measure function μ for *three liters* + *water* in (2) is μ: volume and it is monotonic to ⟦*water*⟧. In contrast, μ: temperature, which is the measure function for *three degrees* + *water* in (3), is not. Hence, only μ: volume satisfies the monotonicity constraint. This analysis can further account for the data in (5). Presumably, when the MP *three inches* combines with *wire*, we should be able to obtain the following two readings: the reading where the length of wire is three inches and the reading where the diameter of wire is three inches. However, in both non-split and split MP constructions, only the length reading is available. We can easily imagine a cable having a part-whole structure in terms of length, but it is very unlikely that a cable has a non-trivial part-whole relation in terms of diameter. Thus, μ: length, but not μ: diameter, can be monotonic to ⟦*wire*⟧, accounting for why only the length interpretation is available in (5).

(5)a.	John-ga	[**waiyaa**	**san-inti**]-o	kinoo	kat-ta	(koto)
	John-NOM	[wire	three-inch]-ACC	yesterday	buy-PAST	

'John bought {three inches of wire / *a three inch wire} yesterday.'

b.	John-ga	**waiyaa**-o	kinoo	**san-inti**	kat-ta	(koto)
	John-NOM	wire-ACC	yesterday	three-inch	buy-PAST	

When a classifier phrase rather than a genuine measure phrase is involved, as in (1), I assume that the relevant measure function is μ: cardinality, since a classifier phrase always expresses the cardinality of an element denoted by the host NP (e.g., in (1), *gakusei* 'student'). This measure function is always monotonic to ⟦NP⟧. For instance, if a set of students has a certain cardinality, and every proper subpart of that set of students will have a lower cardinality, and superparts of that set will have a higher cardinality.

The proposed analysis extends to the examples in (6), where the Japanese non-split and split MP constructions show the same contrast as English pseudopartitives (*ten kilos of meat* versus ??*ten kilos of baby*). We can account for this contrast by saying that *niku* 'meat', but not *akanboo* 'baby', offers a non-trivial part-whole structure where μ: weight applies in a monotonic fashion.[9]

[9] Japanese lacks an obligatory marking of plurality, thus a bare NP can be interpreted as singular or plural (see Chierchia 1998 for discussions on whether Japanese has the mass-count distinction; see also Nakanishi 2004a, 2007; Watanabe 2006, among others). For this reason, there is a possibility of interpreting *akanboo* in (6) as a plural 'babies'. Even so, the oddity in (6) stays the same. Indeed, even in English, *ten kilos of babies* is odd, which is problematic for the monotonicity analysis: plural count NPs like *babies* has a part-whole structure, and μ: weight should be able to apply monotonically to this part-whole structure. I suspect that the oddness of this example can be attributed to pragmatic reasons. In general, plural *babies* are not measured by μ: weight, but by μ: cardinality using numerals (e.g., *three babies*). Thus, when μ: weight is used to measure babies, we tend to imagine a situation where some parts of babies are measured, which leads us to a gruesome interpretation. Indeed, *twenty kilos of babies* sounds better in a context where μ: weight is salient. For example, we might be able to say 'A nurse carried twenty kilos of babies by cart', when a nurse moved babies to a doctor's room using a big cart that can carry up to twenty kilos.

(6)a. John-ga kinoo [{**niku** / ??**akanboo**} **juk-kiro**]-o hakon-da (koto)
John-NOM yesterday [{meat / baby} ten-kilo]-ACC carry-PAST
'John carried twenty kilos of {meat / baby} yesterday.'

b. John-ga {**niku** / ??**akanboo**}-o kinoo **juk-kiro** hakon-da (koto)
John-NOM {meat / baby}-ACC yesterday ten-kilo carry-PAST

2.1.3 Summary

In this section, I showed that both non-split and split MP constructions are subject to some semantic restrictions in terms of nominal predicates. I accounted for this property by appealing to the monotonicity constraint on the nominal domain: the measure function must be monotonic relative to the part-whole structure given by the meaning of the host NP (see (4) for the definition of monotonicity).

2.2 Monotonicity in the verbal domain

So far, we have seen that non-split and split MP constructions have the same restrictions in terms of monotonicity in the nominal domain. This section reveals that these constructions differ at least in three respects: compatibility with single-occurrence events, compatibility with individual-level predicates, and availability of collective readings. These data are explained by extending the monotonicity constraint on the nominal domain to the verbal domain. In particular, I argue that, while the non-split MP construction is sensitive to the monotonicity constraint on the nominal domain, the split MP construction obeys the constraint on the verbal domain.

2.2.1 The data

The first difference between the two constructions is regarding the sorts of VPs that they occur with. The examples in (7) show that the non-split MP construction is compatible with any VP, while not all VPs can be used in the split MP construction. The observation here is that the split MP construction is subject to a restriction on the verbal domain, whereas there is no restriction for the non-split MP construction. More precisely, the split MP construction is incompatible with VPs denoting an event that can occur only once such as *kill Peter*. Indeed, (7b) with *kill* is acceptable in the context where Peter is a zombie who can possibly die multiple times. (8) further confirms the validity of this observation: the single-occurrence events *break that chair* and *make that chair* are compatible with the non-split MP construction, but not with the split MP construction.

(7)a. [**Gakusei san-nin**]-ga kinoo Peter-o {tatai-ta / korosi-ta} (koto)
[student three-CL]-NOM yesterday Peter-ACC {hit-PAST / kill-PAST}
'Three students {hit / killed} Peter yesterday.'

b. **Gakusei**-ga Kinoo **san-nin** Peter-o
student-NOM yesterday three-CL Peter-ACC
{tatai-ta / ??korosi-ta} (koto)
{hit-PAST / kill-PAST}

(8)a. [**Gakusei san-nin**]-ga kinoo sono isu-o
[student three-CL]-NOM yesterday chair-ACC
{kowasi-ta / tukut-ta} (koto)
{break-PAST / make-PAST}
'Three students {broke/made} that chair yesterday.'

b. ??**Gakusei**-ga kinoo **san-nin** sono isu-o
student-NOM yesterday three-CL that chair-ACC
{kowasi-ta / tukut-ta} (koto)
{break-PAST / make-PAST}

The second difference is found with respect to S(tage)-/I(individual)-level predicates, where S-level and I-level predicates correspond to temporary and permanent states, respectively (Carlson 1977). It has been noted in the previous literature that split MPs in Japanese are incompatible with I-level predicates (Harada 1976; Ohki 1987; Fukushima 1991; Nishigauchi and Uchibori 1991; Mihara 1998). In (9), there is a contrast in acceptability between the S-level predicate *genki-dearu* 'be healthy' and the I-level predicate *osu-dearu* 'be male'. (10) shows that the non-split MP construction is compatible with both kinds of predicates. (11) further shows that the same contrast is observed with genuine MPs, assuming *kusat-teiru* 'be rotten' is S-level and *kokusan-dearu* 'be domestic' is I-level.

(9)a. Uti-no doobutuen-de-wa **kaba**-ga mada **san-too** genki-dearu.
our zoo-at-TOP hippo-NOM still three-CL healthy
'In our zoo, three hippos are still healthy.'

b. *Uti-no doobutuen-de-wa **kaba**-ga zannennakotoni **san-too**
our zoo-at-TOP hippo-NOM unfortunately three-CL
osu-dearu.
male
'In our zoo, unfortunately, three hippos are male.' (Mihara 1998: 110–111)

(10)a. Uti-no doobutuen-de-wa [**kaba san-too**]-ga mada genki-dearu.
our zoo-at-TOP [hippo three-CL]-NOM still healthy

b. Uti-no doobutuen-de-wa [**kaba san-too**]-ga zannennakotoni
our zoo-at-TOP [hippo three-CL]-NOM unfortunately
osu-dearu.
male

(11)a. [**Koko-ni aru** **gyuuniku** go-**kiro**]-ga
[here-at be beef five-kilo]-NOM
{kusat-teiru / kokusan-dearu} (koto)
{rotten / domestic}
'Five kilos of beef here are {rotten / domestic}.'

b. **Koko-ni aru** **gyuuniku**-ga **go-kiro**
here-at be beef-NOM five-kilo
{kusat-teiru / ??kokusan-dearu} (koto)
{rotten / domestic}

The third difference is the availability of collective readings. It is well known that sentences with plural subjects can evoke a semantic ambiguity that is not available with singular subjects: while *John made a chair* simply states that John made a chair, *John and Peter made a chair* could mean that John and Peter together made a chair (collective reading) or that each of them made a chair (distributive reading). It has been observed in the previous literature that the split MP construction allows for a distributive reading, but not for a collective reading (Terada 1990; Kitagawa and Kuroda 1992; Ishii 1999; Kobuchi-Philip 2003, among others).[10] For example, the non-split MP construction in (12a) has the collective reading that three boys together made one chair and the distributive reading that each of the three boys made a chair, while the split MP construction in (12b) allows only the distributive reading.[11] Similarly, although (13a) can mean that each of the two friends got married to someone (there were two couples) or that two friends married each other (there was one couple), (13b) allows the former distributive reading only.

(12) a. [**Otokonoko** **san-nin**]-ga kinoo isu-o tukut-ta (koto)
[boy three-CL]-NOM yesterday chair-ACC make-PAST
'Three boys made a chair/chairs yesterday.'

b. **Otokonoko**-ga kinoo **san-nin** isu-o tukut-ta (koto)
boy-NOM yesterday three-CL chair-ACC make-PAST

[10] Some previous studies make a distinction between distributive and non-distributive readings depending on whether or not multiple events occur simultaneously (Kitagawa and Kuroda 1992; Ishii 1999, for example). The distributive-collective distinction here has nothing to do with a temporal relationship, but it is due to agenthood: a distributive reading obtains when each individual in the extension of the plural subject is the agent, and a collective reading obtains when the plural subject as a group is the agent. See Nakanishi (in press) for details.

[11] Note that (12a) has another collective reading where a group of three boys together made a chair multiple times, yielding multiple chairs. (12b) lacks this collective reading. For the sake of simplicity, in this section and Sect. 2.2.2, I only consider the reading where a group of three boys together made one chair. In Sect. 2.3.3, I consider both collective readings and account for why (12b) lacks these readings.

(13) a. [**Tomodati huta-ri**]-ga kyonen kekkonsi-ta (koto)
[friend two-CL]-NOM last year marry-PAST
'Two friends got married last year.'

b. **Tomodati**-ga kyonen **huta-ri** kekkonsi-ta (koto)
friend-NOM last year two-CL marry-PAST

We are now faced with the following question: why are split MP constructions subject to semantic restrictions that are not observed with non-split MP constructions?

2.2.2 The proposal

We have seen in (7) and (8) above that a single-occurrence event such as *kill Peter* is incompatible with the split MP construction. This reminds us of a restriction observed above in terms of the nominal domain. That is, a predicate without non-trivial part-whole structure (e.g., *baby*) is incompatible with non-split and split MP constructions (see (6) above). This similarity opens up a possibility of extending the monotonicity constraint on the nominal domain to the verbal domain. Recall that, in the nominal domain, the measure function applies to an individual in the extension of the host NP, and that the measure function μ must be monotonic relative to the part-whole structure given by the meaning of the NP. In the verbal domain, I assume that the denotation of a verb comes with an event argument (Davidson 1967), and that the measure function applies to an event in the extension of the VP (see Sect. 2.3.1 below for details). Then the measure function μ must be monotonic relative to the part-whole structure given by the meaning of the VP, where monotonicity can be defined as follows:[12]

(14) A measure function μ is monotonic relative to domain E iff:

(i) there are two events e_1, e_2 in E such that e_1 is a proper subpart of e_2, and
(ii) $\mu(e_1) < \mu(e_2)$ (cf.(4))

The data in Sect. 2.2.1 indicate that the split MP construction, but not the non-split MP construction must obey the monotonicity constraint on the verbal domain. Let us first examine the example (7b), the contrast between *hit Peter* and *kill Peter*. It is well known that a verbal predicate can be categorized into two classes, namely, atelic or telic, depending on whether an event described by the verbal predicate has a terminal point; an atelic predicate denotes an event without any terminal point, while a telic predicate denotes an event with an end point. In our case, *hit Peter* is atelic and *kill Peter* is telic. Furthermore, it has been claimed that there are analogies between the mass-count distinction in the nominal domain and the atelic-telic distinction in the verbal domain (ter Meulen 1984; Bach 1986; Krifka 1989).

[12] Note that, in Sect. 2.3.2 below, I refine the proposal here and argue that the monotonicity constraint applies not to events directly, but to individuals mapped from events.

Intuitively, mass NPs and atelic VPs lack a clear limitation, while count NPs and telic VPs come with a precise limit. Given this similarity, we can assume that atelic predicates, but not telic ones, offer a non-trivial part-whole structure (see Sect. 2.3.1 for details). In our case, the denotation of *hit Peter* has at least two members where one is a proper subpart of the other; a hitting-Peter event has a subevent that counts as a hitting-Peter event. The relevant measure function in (7b) is considered to be μ: cardinality (see Sects. 2.1.2 and 2.3), and this function can be monotonic to the part-whole structure of the VP *hit Peter*. In contrast, *kill Peter* does not seem to provide anything but a trivial part-whole structure; a killing-Peter event does not have any subevent that is considered to be a killing-Peter event. According to (14), for the measure function to be monotonic relative to the verbal domain, there needs to be (at least) two events one of which is a subevent of the other. Thus, the measure function cannot be monotonic with respect to the VP *kill Peter*. In contrast, the non-split MP construction is immune to the monotonicity constraint on the verbal domain, and thus it is not sensitive to a part-whole structure of the VP.

The current analysis predicts that telic VPs are compatible with the split MP construction as long as their denotation has a part-whole structure. This prediction is borne out, as in (15). *Kill a mouse* is a telic VP, but, unlike *kill Peter*, it can occur multiple times (since there are multiple mice, as in *John killed a mouse many times last year*) (cf. Zucchi and White 2002). In this sense, *kill a mouse* is pluralized and thus has the plural-part structure.

(15)	*Gakusei*-ga	kinoo	**san-nin**	nezumi-o	korosi-ta (koto)
	student-NOM	yesterday	three-CL	mouse-ACC	kill-PAST
	'Three students killed a mouse/mice yesterday.'				

The monotonicity analysis is capable of further accounting for the second set of data in (9) and (11b): the split MP construction is compatible with S-level predicates, but not with I-level predicates. Kratzer (1995) argues that S-level and I-level predicates differ in that the latter, but not the former, lack event arguments in their denotation. Without event arguments, the VP cannot provide a part-whole relation of events where the measure function is applicable in a monotonic fashion. In this way, the monotonicity constraint cannot be met due to the lack of event arguments.[13] A piece of supporting evidence comes from Mihara's (1998) observation that the split MP construction with I-level predicates becomes acceptable when the split MP is followed by emphatic particles such as -*dake* 'only' and -*tomo* 'all', as shown in (16). Mihara argues that these particles signal that the counting of events described by the sentence is ended, turning I-level predicates into eventive predicates. In (16), the speaker

[13] One of the reviewers pointed out that we could consider I-level predicates to denote some lattice other than a lattice of events. Indeed, some researchers argue that I-level predicates do take an extra argument (e.g., a state argument) (Parsons 1990; Chierchia 1995), which makes it possible for the VP to have a part-whole structure (e.g., a lattice of states). If we claim that the split MP construction requires just any part-whole structure of the VP, the incompatibility with I-level predicates is left unaccounted for. Thus, for the current analysis, it is crucial to assume that the split MP construction requires a lattice of events, and not just any lattice denoted by the VP.

was counting the number of male hippos, and *-dake* 'only' or *-tomo* 'all' indicates that the speaker finished counting. In this sense, unlike (9b), (16) does not describe a permanent state, supporting the claim that the split MP construction requires the existence of event arguments.

(16) Uti-no doobutuen-de-wa **kaba**-ga zannennakotoni **san-too**
our zoo-at-TOP hippo-NOM unfortunately three-CL
{-dake / -tomo} osu-dearu.
{-only / -all} male
'In our zoo, unfortunately, {only/all} three hippos are male.'

Finally, the proposed analysis extends to the observation in (12) and (13) that the split MP construction permits distributive, but not collective readings. One way of obtaining a distributive reading is to posit multiple events taking a different individual as an agent (see Sect. 2.3.3 for details). For instance, under the distributive reading of *the boys made a chair*, we can assume that there are multiple making-a-chair events and that each event takes a different boy as an agent. To put it differently, the VP *make a chair* is pluralized, and if so, it should have a part-whole structure just like plural NPs do. In contrast, the collective reading of the sentence obtains when a single making-a-chair event takes the boys as a group as an agent. Crucially, members of the group do not act as agents, but the whole group does, that is, the group is the agent for a single making-a-chair event. In this sense, *make a chair* under the collective reading is analogous to *kill Peter*; the denotations of these predicates do not have any part-whole structure to which the measure function applies monotonically. As has been argued above, the non-split MP construction is not subject to the monotonicity constraint on the verbal domain. Hence, we expect it to allow both distributive and collective readings, which it does.

2.2.3 Summary

In this section, I first showed that the split MP construction is semantically more restricted than its non-split counterpart at least in three respects: compatibility with single-occurrence events, compatibility with individual-level predicates, and availability of collective readings. Then I argued that the monotonicity constraint on the verbal domain is capable of accounting for the differences. In particular, the split MP construction, but not the non-split MP construction, must obey the monotonicity constraint on the verbal domain, and this difference is responsible for the different semantic properties with respect to verbal predicates.

2.3 Mechanism of event measurement

The discussion in the previous section revealed that the split MP construction differs from the non-split MP construction in that the former, but not the latter, is sensitive to the monotonicity constraint on the verbal domain. This implies that the measure function in the split MP construction applies to a verbal predicate. However, crucially, the split MP construction is semantically different from constructions involving measurement in the verbal domain such as (18). While (17), with the split MP *two*-CL, must involve two students, (18) does not have to: (18) means that a student or students whose cardinality is unspecified coughed twice, that is, *ni-kai* 'twice' is simply counting the number of events without being associated with the number of students (cf. Doetjes 1997). This difference indicates that the measure function in (17) is not applying to events directly, unlike the measure function in (18) that directly measures events.

(17) **Gakusei**-ga kono jup-pun-de **huta-ri** seki-o si-ta (koto)
student-NOM this ten-minute-in two-CL cough-ACC do-PAST
'Two students coughed within the last ten minutes.'

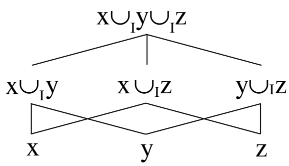
(18) Gakusei-ga kono jup-pun-de **ni-kai** seki-o si-ta (koto)
student-NOM this ten-minute-in two-time cough-ACC do-PAST
'A student/students coughed twice within the last ten minutes.'

Furthermore, recall now the discussion in Sect. 2.1 that both split and non-split MP constructions are subject to some semantic restrictions in terms of nominal predicates. Our assumption then is that the measure function in both constructions applies to individuals denoted by the host NP, and that this application must be carried out monotonically. Indeed, both split and non-split MPs contain a classifier or a measure word that correlates with the host NP. For instance, in (17) above, the MPs contain a classifier *-ri*, which semantically agrees with the host NP *gakusei* 'student', indicating that *huta-ri* 'two-CLASSIFIER' must express the cardinality of the students. In this sense, the measure function μ: cardinality in (17) is applying to individuals denoted by the host NP. Regarding the non-split MP construction, we can simply say that the measure function must apply to the host NP in a monotonic fashion, and thus the constructions are subject to restrictions on the nominal domain. When it comes to the split MP construction, however, we face a dilemma. On the one hand, the construction shows the same nominal restrictions as the non-split counterpart. On the other hand, it also shows verbal restrictions, which are not observed with the non-split one. Thus, it appears to be the case that the measure function in the split MP construction applies both to nominal predicates and to verbal predicates. This section explores the question of how to solve this dilemma. I first introduce formal tools that are necessary for the analysis to come (Sect. 2.3.1). Then I propose a mechanism that maps events in the verbal domain to individuals in the nominal domain and argue that, with the help of this mapping, the measure function in the split MP construction applies to individuals mapped from events (Sect. 2.3.2). In this way, the split MP construction indirectly measures events by measuring individuals. Finally, I apply the proposed mechanism to the empirical data presented in Sects. 2.1.1 and 2.2.1 (Sect. 2.3.3).

2.3.1 Lattice of individuals and of events

We have seen above that mass nouns and plural count nouns come with a non-trivial part-whole structure, while singular count nouns have only a trivial part-whole structure. If we add some elements in the extension of a certain mass or plural count noun, the sum is also in the extension of the same noun (cumulative reference in Quine 1960), whereas this property does not hold for singular count nouns. Link (1983) proposes to capture the difference between the two groups of nouns model-theoretically using a lattice, which is a partially ordered set ordered by a reflexive, anti-symmetric, and transitive relation. Assuming that the denotation of nouns is a set of individuals, mass and plural count nouns can be expressed by ordering the individuals in the extension. For instance, consider (19), where x, y, and z are singular individuals, $\cup_I$ is an individual sum operator, and the lines indicate the part-of relation $\leq$.[14]

(19)



Suppose if x, y, and z are water, then their sums ($x\cup_I y$, $x\cup_I z$, $y\cup_I z$, $x\cup_I y\cup_I z$) are also water, i.e., ⟦*water*⟧ is {x, y, z, $x\cup_I y$, $x\cup_I z$, $y\cup_I z$, $x\cup_I y\cup_I z$}.[15] We can order these members by the part-of relation, as in (19), that is, the extension of a mass noun can be modeled as a lattice of individuals. It has been proposed that a plural count noun is obtained by the operation of semantic pluralization * (Link 1983). The *-operator (the 'star'-operator) applies to a one-place singular predicate *P* and generates all the individual sums of members of the extensions of *P*. With this operator, the denotation of a plural count noun will be a set of atomic elements plus a set of non-atomic elements; if the denotation of *dog* is {x, y, z}, then the denotation of *dog or *dogs* would be {x, y, z, $x\cup_I y$, $x\cup_I z$, $y\cup_I z$, $x\cup_I y\cup_I z$}.[16] Then the members of this set can also be ordered by the part-of relation, as in (19). In contrast, the denotation of a singular count noun is a set of singular individuals, hence no member is a subpart of other members.

[14] In Link (1983), besides singular individuals like John, there are plural individuals or individual sums of type e (individual) like John$\cup_I$Bill that are different from sets like {John, Bill} (see Schwarzschild 1996 for alternative approaches).

[15] Mass nouns are different from plural count nouns in that their minimal parts are somewhat vague (see Bunt 1985 for this issue). In this paper, I simply adopt Chierchia's (1998) view that all nouns, including mass nouns, have minimal parts in their extension. This assumption does not affect the analysis of the paper.

[16] One of the arguments for including a set of atomic individuals in the extension of a plural count noun comes from the interpretation of the determiner *no* (Lasersohn 1988; Schwarzschild 1991). In *no dogs barked*, if ⟦*dogs*⟧ does not include a set of atomic individuals, the sentence is predicted to be true when a single dog barked. However, it is intuitively false, which is predicted by Link's view.

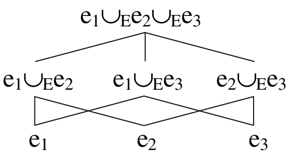
That is, unlike the extensions of mass and plural count nouns, the extension of singular count nouns is not a lattice. Note that part-whole relations of nouns stay the same for noun phrases (NPs): the extension of *old dogs* or *hot water* is a lattice of individuals just like that of *dogs* or *water* is, and the extension of *old dog* as well as that of *dog* is not a lattice.[17]

Turning now to verbal predicates, I briefly discussed in Sect. 2.2.2 that the verbal predicate can be categorized into two classes, namely, atelic or telic, and that there are analogies between the mass-count and the atelic-telic distinction: mass NPs and atelic VPs lack a clear limitation, while count NPs and telic VPs come with a precise limit. With the assumption that the denotation of a verb comes with an event argument, we are able to represent a part-whole structure of verbal predicates by a lattice of events (Krifka 1986, 1989, 1992, 1998; Landman 1996, 2000, in particular). Moreover, following Kratzer (1996, forthcoming), I assume that the denotation of a verb includes an event argument and internal arguments, if any, and that external arguments are introduced by an external agent function.[18] For instance, *hit* is a two-place predicate with an event argument and an internal argument, as in (20a), and the denotation of the VP *hit Peter* is a set of events, as in (20b) (where e for the type of individuals and v for the type of events). The external argument *Mary* is introduced by an agent function, as in (20c) (see Sect. 3 for the compositional analysis).

(20)a. $[\![\textit{hit}]\!] = \lambda x_e.\lambda e_v.\ \text{hit}(x,e)$[19]
b. $[\![\textit{hit Peter}]\!] = \lambda e_v.\ \text{hit}(p,e)$
c. $[\![\textit{Mary hit Peter}]\!] = \exists e[\text{hit}(p,e) \wedge \text{Agent}(e) = m]$

Consider now a set containing elements in (21), where e_1, e_2, and e_3 are singular events, $\cup_E$ is an event sum operator, and the lines indicate the ordering part-of relation $\leq$.

(21)



[17] I assume that the highest projection in the nominal structure is DP, not NP (Abney 1987, among others): $[\![\text{DP}]\!]$ is an individual (or a generalized quantifier), while $[\![\text{NP}]\!]$ is a set of individuals just like the extension of a noun.

[18] Kratzer's (1996, forthcoming) proposal on severing the external argument in the syntax is built on the previous claim that external arguments are not true arguments of their verbs (Williams 1981; Marantz 1984). See Sect. 3.3 below and Nakanishi (2004a, 2007) for discussions on why Kratzer's method is chosen over the standard Davidsonian (Davidson 1967) or the neo-Davidsonian method (Parsons 1990, in particular).

[19] In the following, I follow Montague's notation for type theory: e (the type of individuals) and t (the type of truth values) are the basic types. I also make use of v for the type of events and d for the type of degrees. If σ and τ are semantic types, then $<\sigma,\tau>$ is a semantic type. Nothing else is a semantic type.

Suppose that e_1, e_2, and e_3 are hitting-Peter events.[20] Then, the sums of these events, i.e., $e_1 \cup_E e_2$, $e_1 \cup_E e_3$, $e_2 \cup_E e_3$, and $e_1 \cup_E e_2 \cup_E e_3$, are also hitting-Peter events. That is, ⟦*hit Peter*⟧ is $\{e_1, e_2, e_3, e_1 \cup_E e_2, e_1 \cup_E e_3, e_2 \cup_E e_3, e_1 \cup_E e_2 \cup_E e_3\}$. Since the members of this set can be ordered by the part-of relation, the extension of this atelic VP is a lattice of events, as in (21). Telic VPs are analogous to count NPs; in the same way as a singular count NP like *dog* denotes a set of atomic individuals, a singular telic VP like *break a car* denotes a set of atomic events. What is different is that, unlike NPs, VPs in most languages are not overtly marked for plurality. Even without overt plural marking, however, telic VPs can be pluralized by applying the semantic pluralization operation * used for pluralization in the nominal domain (see Sect. 2.1.3, see also Landman 1989a, b, 2000). A plural telic VP denotes a set containing atomic events and their sums, just like a plural count NP denotes a set containing atomic individuals and their sums. For instance, when ⟦*break a car*⟧ is $\{e_1, e_2, e_3\}$, ⟦**break a car*⟧ is $\{e_1, e_2, e_3, e_1 \cup_E e_2, e_1 \cup_E e_3, e_2 \cup_E e_3, e_1 \cup_E e_2 \cup_E e_3\}$, which can be modeled as a lattice of events, as in (21).

2.3.2 The proposal

The dilemma we are facing is this: the measure function in the split MP construction clearly applies to a VP, but at the same time, it seems to apply to an NP as well. To solve this dilemma, I propose a mechanism that maps events to individuals. With the help of this mapping, the measure function in the split MP construction applies to individuals mapped from events. In this way, the split MP construction indirectly measures events by measuring individuals. This mechanism is similar to Krifka's (1989), which is used to analyze temporal adverbials like *for two hours* in *John slept for two hours* (see also Lasersohn 1995). Krifka claims that temporal adverbials cannot apply to events directly, but they can apply to entities which bear a relation to events, most notably times. That is, *for two hours* indirectly measures the sleeping event by measuring the run time of the event. Formally, he assumes that there is a homomorphism from events E to event run times T. A homomorphism h is a function that preserves some structural relation defined on its domain in a similar relation defined on the range, as in $h(e_1 \cup_E e_2) = h(e_1) \cup_T h(e_2)$, where $\cup_E$ and $\cup_T$ are sum operators for events and times, respectively.[21] Krifka claims that, given a measure function μ for times and h from E to T, we can construe a derived measure function μ' for events, as in (22). That is, a derived measure function is a measure function used for a domain that is different from the original domain of application (e.g., a measure function for times used as a measure function for

[20] Just like mass NPs, minimal parts of atelic VPs are somewhat vague (see Rothstein 2004, for instance). I simply assume here that bottom elements in a lattice of an atelic VP are events which have the same property as the relevant atelic VP.

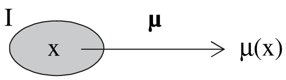
[21] A homomorphism of the semilattice $S1 = \langle S1, \circ \rangle$ into the semilattice $S2 = \langle S2, \circ \rangle$ is a mapping $F : S1 \rightarrow S2$ such that $F(a \circ b) = F(a) \circ F(b)$, where '$\circ$' denotes a composition of two functions (Partee et al. 1990: 286).

events). In (22), the measure function for events μ′ is defined by μ and *h*: for all events, the amount of the event e measured by μ′ in E is equal to the amount of *h*(e) measured by μ in T.

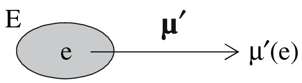
(22) $\forall e\ [\ \mu'(e) = \mu(h(e))\ ]$ (Krifka 1989: 97)

Extending Krifka's analysis to the Japanese data, I argue that there is a homomorphism *h* from events in E denoted by the VP to individuals in I denoted by the host NP, satisfying $h(e_1 \cup_E e_2) = h(e_1) \cup_I h(e_2)$. From the data on non-split MPs, it is clear that there is a measure function that applies to individuals (e.g., in *three liters of water*, μ: volume applies to water). Following Krifka, given a measure function μ for individuals and *h* from E to I, we can derive a measure function μ′ for events. In (23), a measure function μ associated with a non-split MP directly applies to individuals in the grey-shaded area in (23) and returns measured amounts. Thus, the monotonicity constraints apply to a lattice of individuals. In contrast, the measure function μ′ associated with a split MP in (24) applies to events in the grey-shaded area in (24) and returns measured amounts. As in (22), since μ′ for events in (24) amounts to μ(*h*(e)), the same measurement as (24) can be represented as in (25); μ′(e) in (24) (the measured amount obtained by μ′ applying to events) is equal to μ(*h*(e)) in (25) (the measured amount obtained by μ applying to individuals mapped from events), that is, μ′ for events is a combination of *h* and μ for individuals. The measure function μ in (25) associated with a split MP applies to individuals mapped from events by *h*, i.e., individuals in the range of *h* (the grey-shaded area in (25)), indicating that μ indirectly measures events by measuring individuals mapped from events by *h* and that μ needs to be monotonic to the domain of individuals mapped from events.

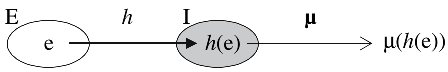
(23) A measure function associated with a non-split MP



(24) A measure function associated with a split MP

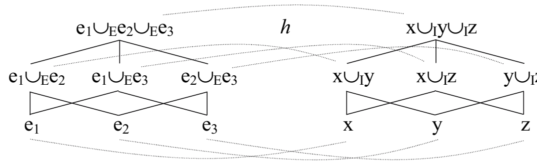


(25) A measure function associated with a split MP



Let us now apply the proposed mechanism to actual examples and show how it works. In (17) above, for example, a homomorphism *h* maps coughing events to relevant individuals, namely, the agents of *coughed*. (26) and (27) illustrate legitimate *h* from a lattice of coughing events to a lattice of students.[22,23] The measure function μ: cardinality in (17) then applies to individuals in the range of *h*. This leads to the following monotonicity constraint: μ must be monotonic to individuals mapped from events, that is, a lattice consisting of x, y, z, $x\cup_I y$, $x\cup_I z$, $y\cup_I z$, $x\cup_I y\cup_I z$ in (26) and a lattice consisting of x, y, $x\cup_I y$ in (27). These two lattices have members that are ordered by the part-of relation (e.g., $x \leq x\cup_I y$), and μ: cardinality is able to apply in a monotonic fashion with respect to the two lattices (e.g., the cardinality of x is lower than the cardinality of $x\cup_I y$). Thus, the monotonicity constraint is met both in (26) and (27).

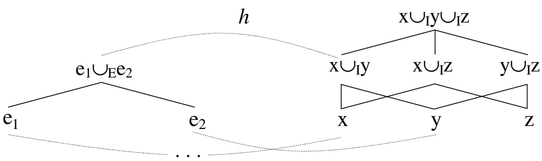
(26)



$[\![{*cough}]\!] = \{ e_1, e_2, e_3, e_1\cup_E e_2, e_1\cup_E e_3, e_2\cup_E e_3, e_1\cup_E e_2\cup_E e_3 \}$

$[\![{*student}]\!] = \{ x, y, z, x\cup_I y, x\cup_I z, y\cup_I z, x\cup_I y\cup_I z \}$

(27)



$[\![{*cough}]\!] = \{ e_1, e_2, e_1\cup_E e_2 \}$

$[\![{*student}]] = \{ x, y, z, x\cup_I y, x\cup_I z, y\cup_I z, x\cup_I y\cup_I z \}$

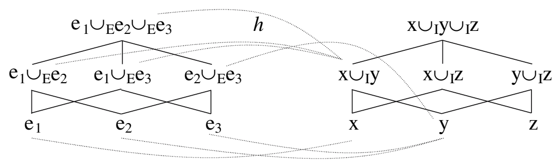
The definition of *h* permits a one-to-many mapping. That is, multiple atomic events may be mapped to one atomic individual, as in (28), where y corresponds to two events. Indeed, (17) is compatible with a scenario in which, between two students who coughed within the last ten minutes, one of them coughed twice. In this scenario, the number of students who

[22] A lattice of coughing events can be much larger than the ones in (26) and (27) in that these events can take individuals who are not in the denotation of **student* as an agent. Since what is relevant for the denotation of (17) is individuals who are students and coughed, I only consider the relevant portion of the lattice of coughing events.

[23] A question arises as to whether the atomic coughing events e_1, e_2, and e_3 can be mapped to the sums of individuals $x\cup_I y$, $x\cup_I z$, $y\cup_I z$, and $x\cup_I y\cup_I z$. Landman (1989a), unlike Link (1983), assumes that atomic verbal predicates never take sums in their extension. With this simple assumption, Landman successfully reduces distributivity to pluralization of a verbal predicate (see Landman 1989a, 2000 for details). As shown in Sect. 2.3.3 below, the current analysis also reduces distributivity to pluralization. Thus, following Landman, I assume here that *h* must map atomic events to atomic (singular or group) individuals. See Nakanishi (2007) for more discussion.

coughed is two, but the number of atomic coughing events is three. The monotonicity is met in (28), just like in (27): the measure function needs to be monotonic to a lattice consisting of x, y, $x \cup_I y$, and the measure function μ: cardinality can be monotonic with respect to this lattice.[24]

(28)



2.3.3 *The analysis of the data*

I have argued so far that the measure function in non-split and split MP constructions must obey the monotonicity constraint: the measure function must be monotonic relative to the given part-whole structure. This constraint applies to the domain where the measure function applies. In the case of the non-split MP construction, the measure function applies to a domain of individuals, thus the constraint must be met in terms of a nominal domain. In contrast, in the split MP construction, the measure function applies to individuals mapped from events by a homomorphism *h*, and thus the monotonicity constraint must be met in the range of *h*, or a nominal domain

[24] Interpretations obtained in the split MP construction are distinct from event-related readings discussed in Krifka (1990). In (i), besides the obvious reading that presupposes the existence of 4,000 ships, Krifka argues that there is an additional reading where *four thousand* refers to a number of events, i.e., there could be fewer than 4,000 ships

(i) Four thousand ships passed through the lock last year.

In the event-related reading in (i), the numeral combining with *ship* measures a number of passing-through-the-lock events. This might have some similarities with the semantics of a split MP, where an MP that is clearly associated with individuals actually measures events. Hence, the mechanism of deriving event-related readings proposed in Krifka (1990) might be applicable to the split MP construction. However, Krifka's mechanism must be different from the mechanism of a homomorphism for the split MP construction, since event-related readings are available in the non-split MP construction as well as in the split MP construction. For example, in (ii), both sentences permit the event-related reading. For this reason, I assume that the grammar contains both Krifka's mechanism for event-related readings and my mechanism of a homomorphism for the split MP construction.

(ii) a. [**Fune** **yonsen-soo**]-ga kyonen kono suimon-o tuukasi-ta (koto)
[ship 4000-CL]-NOM last year this lock-ACC pass-PAST
'4000 ships passed through this lock last year.'

b. **Fune**-ga kyonen **yonsen-soo** kono suimon-o tuukasi-ta (koto)
ship-NOM last year 4000-CL this lock-ACC pass-PAST

mapped from a verbal domain. However, when I first introduced the semantic restrictions on the split MP construction in Sect. 2.2.2, I argued that the restrictions are due to the monotonicity constraint on the verbal domain, that is, the measure function in the split MP construction must be monotonic relative to the part-whole structure given by the meaning of the VP. In the following, I show how the refined proposal where the constraint applies to the range of *h* deals with the relevant semantic restrictions of the split MP construction.

The first set of data in Sect. 2.2.1 indicates that the split MP construction is incompatible with single-occurrence events such as *kill Peter* (in (7b) and (8b)). The incompatibility is now explained as a side-effect of the monotonicity constraint relative to the range of a homomorphism *h*. In the split MP construction, the measure function applies to individuals mapped from events by *h*, and the monotonicity constraint must be satisfied there. In particular, individuals mapped from events by *h* must have a part-whole structure to which the measure function applies monotonically, that is, in the range of *h*, there must be two or more members that are ordered by the part-of relation and the measure function must track that ordering relation. With single-occurrence events, the domain of *h*, namely, the denotation of the VP, is a singleton, thus the range of *h* is also a singleton, given that *h* is a structure-preserving function. Thus, the measure function cannot be monotonic relative to the range of *h*.

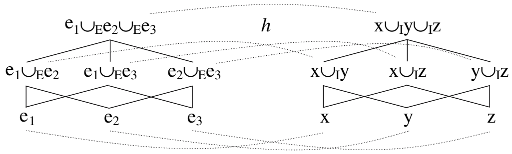
The second observation is that the split MP construction is incompatible with I-level predicates such as *be male* (in (9b) and (11b)). Taking Kratzer's view (1995), I-level predicates has no event argument to begin with, which means that there is no *h* from events. Hence, the measure function does not have an appropriate domain of application.

The third set of data shows that the split MP construction allows for distributive readings, but not for collective readings. Let us examine the example in (12b), which is repeated below:

(29)	**Otokonoko**-ga	kinoo	**san-nin**	isu-o	tukut-ta (koto)
	boy-NOM	yesterday	three-CL	chair-ACC	make-PAST
	'Three boys made a chair/chairs yesterday.'				(=(12b))

Suppose that, in (29), the VP *make a chair* is pluralized and forms a lattice of making-a-chair events, and that there is a homomorphism *h* from that event lattice to a lattice of boys, as illustrated in (30). Then μ: cardinality applies to a range of *h*, i.e., a lattice consisting of x, y, z, $x \cup_I y$, $x \cup_I z$, $y \cup_I z$, $x \cup_I y \cup_I z$. The monotonicity requires μ to be monotonic to this lattice. Since *h* preserves the part-whole structure of events, the monotonicity is met. What is relevant in (29) is an individual mapped from events whose cardinality is three, namely, $x \cup_I y \cup_I z$. The individual $x \cup_I y \cup_I z$ consists of x, y, z, each of whom is an agent of an atomic making-a-chair event e_1, e_2, e_3, which yields a distributive interpretation.

(30)



$[\![*make\ a\ chair]\!] = \{ e_1, e_2, e_3, e_1 \cup_E e_2, e_1 \cup_E e_3, e_2 \cup_E e_3, e_1 \cup_E e_2 \cup_E e_3 \}$

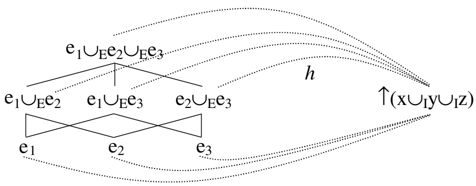
$[\![*boy]\!] = \{ x, y, z, x \cup_I y, x \cup_I z, y \cup_I z, x \cup_I y \cup_I z \}$

The question now is why the split MP construction lacks collective readings. In Sect. 2.2.2 above, I informally assumed that a collective reading of (29) obtains when a single making-a-chair event takes the boys as a group as an agent. Let us formalize this assumption by introducing Landman's (1989a, b, 1996, 2000) group-forming operation $\uparrow$ that maps a sum of individuals (e.g., the sum of the boys x, y, and z; $x \cup_I y \cup_I z$) to an atomic group individual (e.g., the boys as a group; $\uparrow(x \cup_I y \cup_I z)$). A collective reading obtains when a predicate is atomic just like *kill Peter*, and this atomic event takes a group of three boys, as in make.a.chair($\uparrow(x \cup_I y \cup_I z)$). In particular, there is a homomorphism *h* from a singleton containing an atomic making-a-chair event e to the group of three students $\uparrow(x \cup_I y \cup_I z)$, as in (31). The measure function applies to the range of *h*, and the range of *h* is a singleton containing $\uparrow(x \cup_I y \cup_I z)$. Since $\uparrow(x \cup_I y \cup_I z)$ has no part-whole structure that the measure function applies monotonically, the monotonicity constraint fails to be satisfied.

(31)

Note that (29) has another collective reading where a group of three boys made a chair several times (see footnote 11). In this case, multiple making-a-chair events take the same group of three boys as the agent, as in (32). This case is no better than the case in (31): the measure function applies to the range of *h*, namely, a singleton containing $\uparrow(x \cup_I y \cup_I z)$, and thus it fails to be monotonic. In this way, the monotonicity analysis successfully accounts for why the split MP construction lacks collective readings.

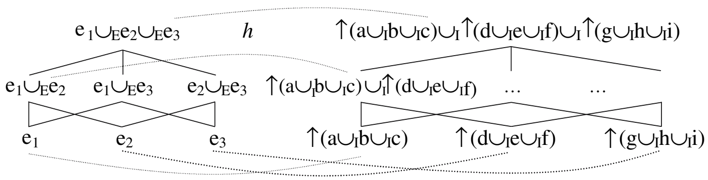
(32)



However, surprisingly, split MPs can occur with so-called collectivizing adverbs (e.g., *together*), as in (33). In this case, only a collective reading is available. I assume that these adverbs rely on Landman's (1989a, b, 1996, 2000) group formation operator $\uparrow$. For example, (33) means that a group of three boys made a chair, where there was only one agent, namely, a group of three boys. Then the question arises as to why the collective reading in (33), but not the one in (29), is acceptable. I would like to point out here that the collective readings in the two sentences are somewhat different in nature; while (33) is compatible with the situation where there are other groups of three boys which made a chair, (29) is incompatible with such a situation. Then, in (33), we could imagine a homomorphism from a lattice of making-a-chair events to a lattice of the group of three boys, as shown in (34). Thus, a seeming collective reading with a collectivizer is not "collective"; it is distributive in that each making-a-chair event is mapped to each group of three boys.

(33) **Otokonoko**-ga kinoo **san-nin** {issyoni / (hito-kumi)-de}
boy-NOM yesterday three-CL {together / (one-group)-by}
isu-o tukut-ta (koto)
chair-ACC make-PAST
'Three boys made a chair/chairs together yesterday.'

(34)



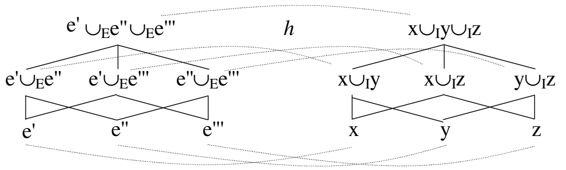
A piece of supporting evidence for the proposed analysis comes from the observation that the split MP construction allows collective readings when a VP is in a progressive form. For instance, (35) is ambiguous between collective and distributive readings.

(35) **Otokonoko**-ga kinoo **san-nin** isu-o tukut-tei-ta (koto)
boy-NOM yesterday three-CL chair-ACC make-PROG-PAST
'Three boys were making a chair yesterday.'

It has been noted that verbal predicates in progressives are tied to a notion of partiality, as informally defined in (36) (Bennett and Partee 1972; Krifka 1992). With this definition, the extension of progressive VPs is considered to be a lattice of subevents. For instance, the making-a-chair event in a progressive form may have subparts e', e'', e''', where e', e'', e''' are subparts of a singular making-a-chair event e. These subparts and their sums form a lattice, where $e' \cup_E e'' \cup_E e'''$ corresponds to e. Then we could postulate *h* in (37); e', e'', e''' are mapped to its agent x, y, z, respectively. Crucially, a singular making-a-chair event e ($= e' \cup_E e'' \cup_E e'''$) is mapped to $x \cup_I y \cup_I z$, which yields a collective reading, although (37) is still distributive in that each individual is an agent of a different subpart of a single making-a-chair event.[25]

(36) PROG = $\lambda P_{<v,t>}\ \lambda e'_v.\ \exists e\ [P(e) \wedge e' \leq e \wedge e'$ is not the final subevent of e]

(37)



⟦*be making a chair*⟧ = {e', e'', e''', $e' \cup_E e''$, $e' \cup_E e'''$, $e'' \cup_E e'''$, $e' \cup_E e'' \cup_E e'''$}

⟦**boy*⟧ = { x, y, z, $x \cup_I y$, $x \cup_I z$, $y \cup_I z$, $x \cup_I y \cup_I z$ }

The current analysis is further supported by the examples in (38), which show that the split MP construction is compatible with a single-occurrence event in a progressive form. In (38), the monotonicity constraint can be satisfied, since the extension of progressive VPs is a lattice of subevents to which the measure function is able to apply monotonically.

(38)a. **Gakusei**-ga kinoo **san-nin** sono isu-o
student-NOM yesterday three-CL that chair-ACC
kowasi-tei-ta (koto)
break-PROG-PAST
'Three students were breaking that chair yesterday.'

b. John-wa [**gootoo**-ga sokode **san-nin** Mary-o
John-TOP [robber-NOM there three-CL Mary-ACC
korosi-tei-ta]-to itta.
kill-PROG-PAST]-COMP said
'John said that three robbers were killing Mary over there.'

Finally, let us go back to the observation in Sect. 2.1.1 that the split MP construction is subject to some semantic restrictions in the nominal domain.

[25] The suffix *-teiru* could yield other interpretations than progressive (Ogihara 1998, in particular), such as the "experience" reading in (i). Under this reading, the collective reading is unavailable. This is because, unlike the "progressive" reading, the "experience" reading does not bring in a notion of partiality.

(i) Sono kaisya-de-wa **syain**-ga kyonen **san-nin** ie-o tate-tei-ru.
that company-at-TOP worker-NOM last year three-CL house-ACC build-TEI-PRES
'At that company, three workers had built a house last year.'

Under the proposed analysis, the measure function in this construction applies to the range of a homomorphism from events, i.e., individuals mapped from events (see (25) above). Then, the measure function must be monotonic with respect to the individuals mapped from events. The measure function such as μ: temperature cannot satisfy this constraint because it cannot keep track of the part-whole structure of the individuals. Moreover, NPs that lack a non-trivial part-of relation (e.g., *cable* in terms of diameter in (5) above) cannot satisfy the monotonicity constraint.

2.3.4 Summary

Summing up, I argued that the measure function in split MP constructions indirectly measures events by measuring individuals mapped from events. Formally, I proposed that there is a homomorphism h from a lattice of events to a lattice of individuals, and that the monotonicity constraint must be met with respect to the range of h. The proposed analysis successfully accounts for why split MP constructions are sensitive to restrictions in the nominal domain as well as restrictions in the verbal domain (incompatibility with single-occurrence events and with I-level predicates, (un)availability of collective readings).

3 The syntax and compositional semantics of non-split/split MP constructions

The goal of this section is to examine whether we can compositionally achieve the monotonicity effects of non-split and split MP constructions discussed in Sect. 2. I first show that non-split and split MPs can be syntactically analyzed as adjuncts adjoined to nominal and verbal predicates, respectively. Based on these structures, I show that the semantic properties of the two constructions can be derived compositionally.

3.1 The syntax[26]

MPs in English is known to have a wide distribution, as in *two meters long*, *two meters of rope*, *two meters away*, *walk two meters* (Jackendoff 1977). The same holds for Japanese, as in (39). This distributional property of MPs naturally follows if we assume that an MP is an adjunct that can adjoin to various

[26] The main concern of this section is to seek for syntactic structures of non-split and split MP constructions that are compatible with the semantic properties discussed above. For this reason, I left out several issues widely discussed in the syntactic literature on Japanese nominal phrases (e.g., syntactic differences between MPs and ClPs, the location of case markers, etc.). For these issues, see Watanabe (2006), among others.

maximal projections (e.g., AP in (39a), NP in (39b), PP in (39c), VP in (39d)), as in $[_{AP/NP/PP/VP}$ MP $[_{AP/NP/PP/VP} \cdots]]$.[27]

(39)a. **ni meetoru** nagai[28]
two meter long
'two meters longer/too long'

b. roopu **ni meetoru**[29]
rope two meter
'two meters of rope'

c. **ni meetoru** hanarete
two meter away
'two meters away'

d. **ni meetoru** aruku
two meter walk
'walk two meters'

The proposed adjunct analysis implies that there is no transformational relation between non-split and split MP constructions; the split MP is base-generated as a VP-adjoined element like VP-adverbs. Indeed, the adverbial analysis for the Japanese split MP constructions has been advocated by several researchers (Fukushima 1991; Fujita 1994; Ishii 1999; Kobuchi-Philip 2003; in particular, see Nakanishi (in press) for a summary),[30] as opposed to the transformational analysis, which claims that a split MP and its host NP are in the same nominal projection at the underlying structure and that the host NP moves higher, stranding the MP. There are two main arguments against the transformational analysis. First, there are a number of examples where the split MP construction lacks a non-split counterpart. Second, there are a wide variety of examples indicating semantic differences between the two constructions. Indeed, I have shown in Sect. 2.2 that the two constructions differ in terms of compatibility with single-occurrence events and with I-level predicates, and of availability of collective readings. We may be able to argue that semantic differences per se do not rule out the transformational approach. However, it is not clear how syntactic movements are associated with the types of semantic differences discussed here.

[27] A similar argument for the adjunct analysis can be found in Doetjes (1997: 94), where she argues that cross-categorial degree quantifiers in French such as *combien* 'how many/much' in (i) are adjuncts.

(i) a. Combien$_i$ as-tu lu $[_{NP}$ t$_i$ $[_{NP}$ de livres]]?
how many have-you read of books
'How many books did you read?'

b. Combien$_i$ les enfants ont-ils $[_{VP}$ $[_{VP}$ ri] t$_i$]?
how much the children have-they laughed
'How much did the children laugh?'

c. Vous verrez combien$_i$ il est $[_{AP}$ t$_i$ $[_{AP}$ méchant]].
you will see how much he is evil
'You will see how evil he is.'

[28] In Japanese, when MPs occur with gradable adjectives, the sentence is always interpreted as a comparative construction, as reflected in the translation in (39a) (see Nakanishi 2004b).

[29] To derive the surface order in (b), I assume that the NP obligatorily moves to a specifier of the higher projection, i.e., Spec DP (see Saito and Murasugi 1999 for the existence of DP in Japanese).

[30] The previous studies put emphasis on the fact that split MPs are categorized as adverbs. This point is not crucial here as long as split MPs are analyzed as adjuncts adjoined to verbal predicates.

Our task now is to figure out the exact syntactic structure of the split MP construction under the assumption that a split MP is adjoined to a verbal predicate. It has been argued that a split MP must be c-commanded by its host NP, based on the data such as (40) (Miyagawa 1989). In (40), the classifier *-nin* semantically agrees with *tomodati* 'friend', but not with *kuruma* 'car'. Under the intended interpretation, the host NP *tomodati* 'friend', being embedded, cannot c-command the split MP. The same analysis extends to the observation that a split MP can be associated with an argument, but not with an adjunct (Okutsu 1969; Harada 1976; Shibatani 1977; Inoue 1978; Kuno 1978). More specifically, while external and internal arguments of the verb are possible antecedents of the split MP, as in (41a), PPs cannot host the split MP, as in (41b). It has been argued that there is a structural difference between arguments and adjuncts. For instance, Miyagawa (1998) argues that the case marker *-o* in (41a) is cliticized onto the argument *kuruma* 'car', whereas the postposition *-de* in (41b) has its own projection. Then, while the host NP in (41a) can c-command the MP, the host NP in (41b) cannot, being embedded in the PP whose head is *-de*.

(40) *[**Tomodati**-no kuruma]-ga **san-nin** kosyoosi-ta.
[friend-GEN car]-NOM three-CL break down-PAST
'Three friends' car(s) broke down.' (Miyagawa 1989: 29)

(41)a. Gakuseitati-wa **kuruma**-o **ni-dai** kat-ta.
students-TOP car-ACC two-CL buy-PAST
'Students bought two cars.'
b. *Gakuseitati-wa **kuruma**-de **ni-dai** ki-ta.
students-TOP car-in two-CL come-PAST
'Students came in two cars.' (Miyagawa 1989: 31)

We have seen that the host NP must be either an external or an internal argument and that it must c-command the split MP. Let us now turn to the question of where split MPs are situated. Among various syntactic diagnostics used to answer this question (see, for example, Miyagawa 1989; Fujita 1994; Koizumi 1994), I present here the data on VP-preposing, a construction where the VP followed by *-sae* 'even' is moved to sentence-initial position. If a split MP appears in a preposed constituent, it must be syntactically within VP. If it appears outside, it must be outside VP. The examples in (42) show that a split MP associated with an external argument must be outside VP, while the examples in (43) show that a split MP associated with an internal argument must be within VP. Putting these together, I propose that the split MP associated with an external argument is adjoined to the VP, and it is c-commanded by the host NP, which is at the specifier position of a higher projection. Following Kratzer (1996, forthcoming), I assume that the projection above VP is VoiceP, and that the head of VoiceP takes the agent function which introduces an external argument. In this structure, the host NP is at Spec of VoiceP, as in (44a) (see also (55b) below). The split MP associated with an internal argument is adjoined to V′, and it is c-commanded by the host NP, which is at the spec of VP, as in (44b) (see also (64) below).

(42)a. [$_{VP}$ Mary-o home-sae]$_i$ **gakusei**-ga **san-nin** t_i si-ta.
[Mary-ACC praise-even] student-NOM three-CL do-PAST
'Even praise Mary, three students did.'
b. *[$_{VP}$ **San-nin** Mary-o home-sae]$_i$ **gakusei**-ga t_i si-ta.
[three-CL Mary-ACC praise-even] student-NOM do-PAST
'(lit.) Even praise Mary three, students did.'

(43)a. *[$_{VP}$ **Katuo**-o tabe-sae]$_i$ Taroo-ga **san-biki** t_i si-ta.
[bonito-ACC eat-even] Taro-NOM three-CL do-PAST
'(lit.) Even eat bonitos, Taro three did.'
b. [$_{VP}$ **Katuo**-o **san-biki** tabe-sae]$_i$ Taroo-ga t_i si-ta.
[bonito-ACC three-CL eat-even] Taro-NOM do-PAST
'Even eat three bonitos, Taro did.'

(44)a. [$_{VoiceP}$ NP [$_{VP}$ split MP [$_{VP}$ …]] Voice]
b. [$_{VoiceP}$ … [$_{VP}$ NP [$_{V'}$ split MP [$_{V'}$ …]]] Voice]

3.2 The semantics

In the previous section, I showed that non-split MPs and split MPs directly combine with nominal and verbal predicates, respectively, in the syntax. Based on these syntactic structures, this section compositionally derives semantic interpretations of the two constructions.

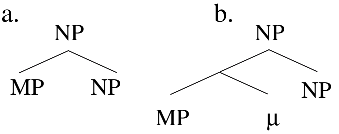
Following the standard treatment of MPs in comparatives (e.g., *This rope is two meters long*), I assume that MPs are interpreted as a name of a degree, as in ⟦*two meters*⟧ = 2 meters of type d. Furthermore, I assume that a measure function is a function from an object to a name of a degree.[31] Recall now Schwarzschild's (2002) claim discussed in sect. 2.1.1 that a measure function μ is a measurement scheme (e.g., volume, temperature, depth, etc.) that is obtained by examining a relation between an MP and the element to which the MP applies. For instance, in *two meters of rope*, since *two meters* specifies how long the relevant rope is, the measure function is μ: spatial-length. The denotation of this example is given in (45). The next step is to compositionally derive this denotation. The syntactic structure of (45) is given in (46a). A question arises as to where the measure function μ is coming from; μ is a measurement scheme obtained from the relation between an MP and a measured element, and it is not realized overtly. Among various possibilities (cf. Schwarzschild 2002: 237), I

[31] Alternatively, an MP can be treated as a predicate of scalar intervals (Schwarzschild and Wilkinson 2002), in which case, a measure function is a function from an object to an interval on a scale (Schwarzschild 2002). As shown in Nakanishi (2004a), the compositional analysis in this section holds under the interval semantics as well.

adopt the structure in (46b), where μ first combines with an MP and MP + μ combines with the NP.

(45) $[\![$*two meters of rope*$]\!] = \lambda x_e.\ \mathrm{rope}(x) \wedge \mu(x) = 2$ meters, where μ: spatial-length

(46) a. b.



Traditionally, the semantic treatment of cardinality quantifiers (numerals and genuine MPs) has been controversial in that they can be treated as modifiers or as determiners in the sense of the theory of generalized quantifiers. In this paper, I take the former view that cardinality quantifiers are modifiers, similar to adjectives.[32] In (46b), MP + μ is a modifier combining with *rope* of type $<e,t>$. A modifier can be treated to be a predicate of the same semantic type as a modified element or to be a function that takes a modified element as an argument. I take the second view, for reasons that will become clear shortly. The denotation of μ is given in (47), and the compositional semantics of *two meters of rope* is spelled out in (48). μ first takes the MP in (48a) as an argument, as in (48b), and MP + μ combines with the NP, and the MP signals what kind of measure function is available: with *two meters*, μ must be something like μ: length or μ: depth (but not μ: weight, μ: cardinality, etc.), yielding length(x) = 2 meters or depth(x) = 2 meters. Among these possibilities, the NP determines which measure function needs to be used; when *two meters* + μ combines with *rope*, as in (48d), μ is determined to be μ: length, not μ: depth.

(47) $[\![\mu_{NP}]\!] = \lambda d_d.\lambda P_{<e,t>}.\lambda x_e.\ P(x) \wedge \mu(x) = d$ (first version)

(48)a. $[\![$*two meters*$]\!] = 2$ meters
b. $[\![$*two meters* + $\mu]\!] = \lambda P_{<e,t>}.\lambda x_e.\ P(x) \wedge \mathrm{length/depth}(x) = 2$ meters
c. $[\![$*rope*$]\!] = \lambda x_e.\ \mathrm{rope}(x)$
. d. $[\![$ *two meters of rope*$]\!] = \lambda x_e.\ \mathrm{rope}(x) \wedge \mathrm{length}(x) = 2$ meters

[32] Under the theory of generalized quantifiers, cardinality quantifiers express a relation between the set of individuals denoted by the NP and the set of individuals denoted by the VP. However, this analysis needs some adjustment if an event argument is introduced, since, with an event argument, the VP no longer denotes a set of individuals. Although, for simplicity, I consider cardinality quantifiers to be modifiers, it is possible to analyze them as determiners even with event arguments and to maintain the mechanism of a homomorphism from events to another domain, following the analysis of *for the most part* in English proposed in Nakanishi and Romero (2004) (see also Herburger 2000; Beaver and Clark 2003).

Recall that a measure function μ associated with an MP in pseudopartitives must satisfy the monotonicity constraint on the nominal domain (see Sect. 2.1). For instance, in *two meters of rope*, μ: length has to be monotonic to ⟦*rope*⟧. Schwarzschild (2002) proposes the denotation in (49a) for MPs in pseudopartitives, where MON(μ,X) means that μ is monotonic with respect to X.[33] Note that the monotonicity constraint is incorporated into the assertion of the denotation of MPs. The compositional semantics of *two meters of rope* based on Schwarzschild's analysis is given in (49b), where the measure function is μ: length. However, this analysis incorrectly predicts (50a) to be not just grammatical and felicitous, but also to be necessarily true. Consider the truth condition in (50b). MON(tmp., water) is false, since μ: temperature is not monotonic to ⟦*water*⟧, which makes the formula under the negation false. With the negation at the top, the entire sentence is true even if all relevant water disappeared, which is contrary to our intuitions.

(49)a. $[\![\mathrm{MP}]\!] = \lambda X_{<e,t>}.\lambda z_e.\ X(z) \wedge \mu(z) = mp \wedge \mathrm{MON}(\mu,X)$

b. $[\![\textit{two meters of rope}]\!] = \lambda z_e.\ \mathrm{rope}(z) \wedge \mathrm{length}(z) = 2\ \mathrm{meters} \wedge \mathrm{MON}(\mathrm{length},\mathrm{rope})$

(50)a. #90 degrees of water didn't disappear.

b. $\neg\exists z[\mathrm{water}(z) \wedge \mathrm{tmp.}(z) = 90\ \mathrm{degrees} \wedge \mathrm{MON}(\mathrm{tmp.},\ \mathrm{water}) \wedge \mathrm{disappear}(z)]$

Alternatively, I minimally modify Schwarzschild's denotation and propose to put the monotonicity constraint in the presupposition. Since an MP is a name of a degree, the presupposition must be encoded in the denotation of μ, as in (51). μ first combines with the MP, and then MP + μ takes the host NP as an argument. Note that, if MP + μ is of the type < e,t > (λx_e. length/depth(x) = 2 meters), we are unable to add in the presupposition the monotonicity constraint posed by μ. The truth condition of (50a) is given in (52), which has the presupposition MON(tmp., water). Since this presupposition cannot be met, (50a) is predicted to be always infelicitous. In Sect. 2.1, we have seen that the semantic properties of the Japanese non-split MP construction are the same as the properties of the English pseudopartitives. Assuming that the MP, the measure function, and the NP combine in the same way in these constructions, the current proposal on the English pseudopartitive should extend to the Japanese non-split MP construction. Thus, the denotation of a measure function μ associated with non-split MPs is (51). The truth condition of (53a) then is (53b).

(51) $[\![\mu_{\mathrm{NP}}]\!] = \lambda d_d.\lambda P_{<e,t>}\!: \mathrm{MON}(\mu,P).\lambda x_e.\ P(x) \wedge \mu(x) = d$

(revised version)

(52) $\neg\exists z[\mathrm{water}(z) \wedge \mathrm{temperature}(z) = 90\ \mathrm{degrees} \wedge \mathrm{disappear}(z)]$

[33] Regarding the question of where μ comes from in pseudopartitives, Schwarzschild (2002) assumed that μ is grafted on to the meaning of the MP. Thus, his MP corresponds to our MP + μ.

(53)a. [**Mizu san-rittoru**]-ga kobore-ta (koto)
[water three-liter]-NOM spill-PAST
'Three liters of water spilled.'
b. $\exists$y[water(y) $\wedge$ volume(y) = 3 liters $\wedge$ spill(y)]
Presupposition: μ: volume must be monotonic to ⟦*water*⟧.
Assertion: There is water y such that y spilled and the volume of y is 3 liters.

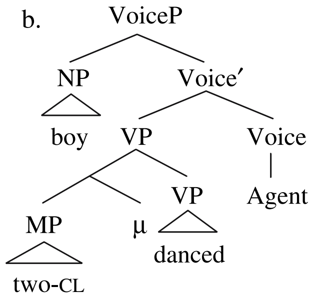
We can further extend the analysis on *two meters of rope* to examples such as *walk two meters*, where the MP combines with a VP. The denotation of μ for events is provided in (54a), which is completely parallel to the denotation of μ for NPs in (51). As in (48), when μ combines with the MP *two meters*, we obtain the sub-formula μ(e) = 2 meters, indicating that the measurement of an event e by μ yields 2 meters. This signals that μ must be something like μ: spatial-length or μ: depth, yielding spatial-length(e) = 2 meters or depth(e) = 2 meters, respectively. However, an event *per se* does not have a spatial length nor a depth, but its path does. This is analogous to the fact that temporal adverbials like *for three hours* do not apply to events directly, but to temporal traces of events, as discussed in Sect. 2.3.2. Thus, we need a homomorphism *h* from events to their paths to make μ: spatial-length or μ: depth applicable to events (Lasersohn 1995; Krifka 1998, in particular). μ associated with a split MP also requires *h*, in particular, *h* from events to individuals. In this case, as discussed in Sect. 2.3.2, the measure function must be monotonic to the range of *h*. Thus, instead of (54a), I propose (54b) as a denotation of μ associated with MPs combining with a VP (*two meters* in *walk two meters*, *five hours* in *sleep five hours*, split MPs, etc.). MON(μ, $\mathrm{Range}_P(h)$) means that the measure function μ is monotonic to the range of *h* from a set of events in P. In the case of split MP constructions, $\mathrm{Range}_P(h)$ is a set of all individuals mapped by *h* from some event in P, that is, $\{x: \exists e \in P[h(e) = x]\}$.

(54)a. $[\![\mu_{VP}]\!] = \lambda d_d.\lambda P_{<v,t>}: \mathrm{MON}(\mu,P).\ \lambda e_v.\ P(e) \wedge \mu(e) = d$ (first version)
b. $[\![\mu_{VP}]\!] = \lambda d_d.\lambda P_{<v,t>}: \mathrm{MON}(\mu, \mathrm{Range}_P(h)).\lambda e_v.\ P(e) \wedge \mu(h(e)) = d$ (revised version)

The general picture is that an MP signals what kind of measure function μ for events is needed, which in turn determines what kind of *h* is called for. In the case of split MPs discussed so far, *h* is from events to individuals, since split MPs carry a measure word or a classifier that semantically agrees with its host NP. Consider, for instance, the split MP construction in (55a), whose LF and compositional semantics are provided in (55b). By combining μ for VPs and the MP 'two-CL', we obtain the sub-formula μ(*h*(e)) = 2 individuals. This signals that μ must be μ: cardinality, yielding cardinality(*h*(e)) = 2 individuals, where *h* is from events to individuals. Since there is a presupposition that μ must be monotonic to the range of *h*, we can account for why the split MP construction has the properties discussed in Sect. 2.2.1 (incompatibility with single-occurrence events and with I-level predicates, (un)availability of collective readings).

(55)a. **Otokonoko**-ga **huta-ri** odot-ta (koto)
boy-NOM two-CL dance-PAST
'Two boys danced.'

b.



⟦*two*-CL⟧ = 2 individuals
⟦*two*-CL + μ⟧ = $\lambda P_{<v,t>}$: MON(cardinality, $\text{Range}_P(h)$).λe_v. P(e) ∧ cardinality(h(e)) = 2 individuals
⟦*dance*⟧ = λe_v. *dance(e)
⟦VP⟧ = λe_v. *dance(e) ∧ cardinality(h(e)) = 2 individuals
⟦Voice⟧ = $\lambda x_e.\lambda e_v$. Agent(e) = x
⟦Voice′⟧ = $\lambda y_e.\lambda e_v$. Agent(e) = y ∧ *dance(e) ∧ cardinality(h(e)) = 2 individuals[34]
⟦NP⟧ = λx_e. *boy(x)
∃ + ⟦NP⟧ = $\lambda P_{<e,vt>}.\lambda e_v$. ∃x[*boy(x) ∧ P(x)(e)][35]
⟦VoiceP⟧ = λe_v. ∃x[*boy(x) ∧ Ag(e) = x ∧ *dance(e) ∧ cardinality(h(e)) = 2 ind.]
⟦TP⟧ = 1 iff ∃e∃x[*boy(x) ∧ Ag(e) = x ∧ *dance(e) ∧ cardinality(h(e)) = 2 ind.]
Presupposition: μ: cardinality must be monotonic to the range of h.
Assertion: There is a plural dancing event e by x and there is x such that x is a boy/boys. μ applied to h(e) yields 2 individuals.

3.3 Homomorphism other than agent

I have been assuming that, when a split MP takes a subject (or more specifically, an external argument) as a host NP, the relevant homomorphism is the agent function. For example, in (55a), h maps a set of dancing events to a set of students. There are two issues that arise from this assumption. First, recall that, besides external arguments, internal arguments can serve as a host NP, as shown in (41a). Given that

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[34] This step is done by Kratzer's Event Identification in (i) (Kratzer 1996: 122).

(i) Event Identification: f $<e,<v,t>>$ g $<v,t>$ → h $<e,<v,t>>$ $\lambda x_e.\lambda e_v$. f(x)(e) ∧ g(e)

[35] The definition of ∃ is given in (i), which is like Partee's (1987) rule in (ii) except that (i) is with event arguments.

(i) ∃: $<e,t>$ → $<<e,vt>,vt>$ ∃X = $\lambda P_{<e,vt>}.\lambda e_v$. ∃x[X(x) ∧ P(x)(e)]
(ii) ∃: $<e,t>$ → $<et,t>$ ∃X = $\lambda P_{<e,t>}$. ∃x[X(x) ∧ P(x)]

internal arguments are not agents, the agent function cannot be the relevant homomorphism here. If it is not an agent function, what function relates events to individuals? Second, notice that nothing in the formula in (55b) says that h is the agent function, that is, nothing forces us to use the agent function as the relevant homomorphism. We need to find a way to specify which function plays a role.

Before addressing the two issues, let us first examine formal properties of homomorphisms. Suppose that there are two elements of the sort S. Then h from S to S′ maps the sum of x and y in S, i.e., $x \cup_S y$, to the sum of h(x) and h(y) in S′, i.e. $h(x) \cup_{S'} h(y)$, as defined in (56). That is, h must be a function and it must be structure preserving. The structure preserving nature of h is reminiscent of the property of cumulativity, which is defined in (57): if x and y of the sort S have a property P, the sum of x and y has the same property. Cumulativity can be defined as a property of relations between two sorts (in (58a)) or as a property of functions from elements in the sort S to elements in the sort S′ (in (58b)). Functional cumulativity in (58b) essentially expresses the defining property for h in (56), i.e., $F(a \cup_S b) = F(a) \cup_{S'} F(b)$. Thus, any relation that is functional and cumulative can serve as h. I now examine whether the agent association is functional and cumulative. First, it is functional because the agent role of a certain event must be uniquely specified (Carlson 1984; Parsons 1990; Landman 2000). Second, it is cumulative in that, if x and y are the agent of e and e′, respectively, the sum of x and y is the agent of the sum of e and e′, as in (59a) (Krifka 1986, 1989, 1992, 1998; Landman 1996, 2000, Kratzer forthcoming). Let us examine a slightly modified example from Kratzer (forthcoming): suppose that John dug a hole, Mary placed a tree in the hole, and Bill covered the roots with soil, and that the entire planting-a-tree event is the sum of these three subevents. The agents of these subevents are John, Mary, and Bill, respectively. It is true to say that the sum of these three individuals planted the tree, i.e., the sum of the individuals is the agent of the planting-a-tree event. Thus, the agent relation is cumulative, as in (59a).[36] Since (59a) is equivalent to (59b), it follows that, when the host NP of a split MP is an external argument, the agent function serves as h from events to individuals.

(56) $\forall h\ \forall x,y \in D_S\ [\ h(x \cup_S y) = h(x) \cup_{S'} h(y)\ ]$

(57) P is cumulative iff: $\forall x,y \in D_S\ [\ [P(x) \wedge P(y)] \rightarrow P(x \cup_S y)\ ]$

(58) a. $\forall R\ \forall a,b \in D_S\ \forall x,y \in D_{S'}\ [\ [R(a)(x) \wedge R(b)(y)]$
$\rightarrow R(a \cup_S b)(x \cup_{S'} y)\ ]$
b. $\forall F\ \forall a,b \in D_S\ \forall x,y \in D_{S'}\ [\ [F(a) = x \wedge F(b) = y]$
$\rightarrow F(a \cup_S b) = x \cup_{S'} y\ ]$

[36] An anonymous reviewer pointed out that the agent function does not seem to be cumulative in the following scenario: the doctor examined the patient, where the examination has subevents such as the patient lifts his arm, the patient breathes heavily, etc. If the agent function were cumulative, we would mistakenly predict that both the doctor and the patient are the agents. The problem here seems to lie on how to determine relevant subevents. In this case, I assume that the events of patient's lifting-the-arm and breathing-heavily are caused by the doctor, i.e., the doctor made the patient to lift the arm or to breath heavily, and thus the doctor is the agent of these subevents.

(59)a. $\forall e,e' \in D_E\ \forall x,y \in D_I\ [[\text{Agent}(e) = x \wedge \text{Agent}(e') = y]$
$\rightarrow \text{Agent}(e \cup_E e') = x \cup_I y]$
b. $\text{Agent}(e \cup_E e') = \text{Agent}(e) \cup_I \text{Agent}(e')$

Let us now turn to one of the questions at issue: in the case where the split MP takes an internal argument as its host NP, as in (60), what function maps events to individuals?

(60) John-ga **ki**-o kinoo **san-bon** ue-ta (koto)
John-NOM tree-ACC yesterday three-CL plant-PAST
'John planted three trees yesterday.'

The obvious candidate would be the theme function. It has been proposed by Krifka (1986, 1989, 1992, 1998) and pursued by Landman (1996, 2000) that the denotations of all thematic functions are cumulative, which Kratzer (forthcoming) refers to as the Cumulativity Universal (see also Sternefeld 1998). Then, in (60), the theme function serves as a homomorphism from events to their themes, $\text{Theme}(e_1 \cup_E e_2) = \text{Theme}(e_1) \cup_I \text{Theme}(e_2)$. However, Kratzer's (forthcoming) recent work shows that the agent function, but not the putative theme function, is cumulative. Let us take up the example above where a planting-a-tree event consists of three subevents; John dug a hole, Mary placed a tree in the hole, and Bill covered the roots with soil. If the putative theme function exists, cumulativity requires that the sum of a hole, a tree, and the roots is the theme of the planting event. However, intuitively, the theme of the planting event is the tree alone. Thus, themes are different from agents in that they are not summed. Kratzer's assumption is that, if arguments of verbs are introduced by secondary predicates denoting general thematic functions like the agent function, there should be a conceptual property shared by all the relations. Krifka's work showed that cumulativity can be such a property. Then, the fact that the putative theme function is not cumulative indicates that there is no theme function to begin with. That is, themes are not introduced by the theme function. If there is no theme function, how are themes introduced, and furthermore, what serves as a homomorphism from events to themes in (60)? What becomes relevant here is Kratzer's (forthcoming) claim that verb denotations—which are relations between events and their internal argument individuals—are cumulative. Under Kratzer's theory presented in (20) above, the denotation of verbs with internal arguments includes an event argument and an internal argument, but not an external argument. For example, the denotation of the transitive verb *plant* would be $\lambda x \lambda e.\ \text{plant}(x,e)$. These verbs denote relations between individuals and events. Kratzer argues that these relations are cumulative. For example, if e_1 is a planting-roses event and e_2 is a planting-tulips event, the sum of these two events is an event of planting roses and tulips, satisfying the definition of cumulativity in (61).

(61) $\forall x,y \in D_I\ \forall e_1,e_2 \in D_E\ [\ [\text{plant}(x,e_1) \wedge \text{plant}(y,e_2)]$
$\rightarrow \text{plant}(x \cup_I y,\ e_1 \cup_E e_2)\ ]$

For the purpose of this paper, there does not seem to be any problem in treating a relation between individuals denoted by the internal argument and events as a function from events to individuals, as in plant(e) = x.[37] The only change that this move brings in is the assumption that each event is associated with a unique theme individual. In fact, this is exactly what Krifka's (1986, 1989, 1992) notion of uniqueness of objects (UNI-O) in (62) expresses: each event associates with a unique individual. Krifka claims that the relation between events and their themes must satisfy the uniqueness of objects. For instance, in *plant a tree*, each planting event is related only to a unique tree, and to nothing else.

(62) $\forall R[\mathbf{UNI\text{-}O}(R) \leftrightarrow \forall e \forall x \forall y[R(x,e) \wedge R(y,e) \rightarrow x = y]]$
(Krifka 1989: 92)

Following Kratzer's claim, I assume that denotations of transitive verbs are relations between individuals and events, as I have been assuming, and that these relations are cumulative. Furthermore, based on (62), these relations can be represented as functions, as in (63a), which is equivalent to (63b). Hence, denotations of transitive verbs are functional and cumulative, which satisfies the conditions for a legitimate homomorphism from events to individuals.[38]

[37] Kratzer's (1996, forthcoming) denotation of *plant*, a function f of type $<e,<v,t>>$, can be viewed as the right-to-left Schönfinkelization of the function f′ of type $<<v,e>,t>$. This last function, in turn, is mathematically equivalent to the characteristic set $\{<x_e, e_v> : f'(x,e) = 1\}$. This final set of pairs is the function from events to individuals that we need.

[38] The proposed difference between external and internal arguments may be related to the following observation on collectivity: while the split MP construction with the external host NP disallows collective readings in principle, as shown in (12b) and (13b), the split MP construction with the internal host NP seems to allow "collective" readings; (i) can mean that John made five different cocktails separately (distributive), or that John put together five cocktails and made a mysterious drink (collective).

(i) John-ga **kakuteru**-o syeikaa-de **go-hai** maze-ta (koto)
John-NOM cocktail-ACC shaker-by five-CL mix-PAST

'John mixed five cocktails by shaker.'

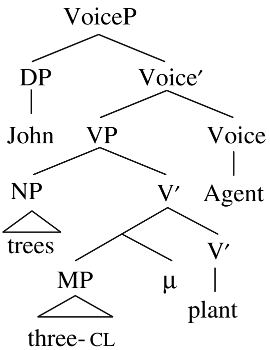
However, note that the collective readings with respect to a plural internal argument seem to be different in nature from collective readings with respect to a plural external argument. In (i), if John mixed five drinks to make a mysterious drink, then he must have mixed four drinks, three drinks, and so on (cf. Dowty's (1987) distributive sub-entailment). In contrast, there is no such entailment with external arguments; under its collective reading, *five boys made a chair* does not implicate that the smaller number of boys could have made a chair. More generally, there seem to be no genuine collective readings with respect to a plural internal argument that do not have this entailment. If the internal argument is always in the denotation of a verb, as assumed in this paper, the pluralization of the internal argument leads to the pluralization of events, which yields the (semi-)distributive reading. This may further relate to the previous claim that there is an inherent incremental relationship between an event and its internal argument; "ADD-TO" property (Verkuyl 1972, 1993), "measuring out" (Tenny 1987, 1994), "graduality" (Krifka 1989, 1992), "incremental theme" (Dowty 1991), and "structure-preserving binding relations" (Jackendoff 1996). For example, in *drink wine*, there is an incremental relationship between the drinking event and its internal argument *wine* in that, as the drinking event proceeds, the amount of wine consumed increases. When we have plural internal arguments, as in (i), we can say that a homomorphic relation between events and themes are inherently given; there is an inherent incremental relation between the mixing event and drinks, i.e., the number of drinks increases as the mixing event proceeds, hence we obtain the entailment described above. In contrast, there is no incremental relationship between an event and its external argument (Tenny 1987, 1994, in particular). See Nakanishi (2004a, 2007) for more discussions on distributivity and incrementality.

(63)a. $\forall x,y \in D_I\ \forall e_1,e_2 \in D_E$ [[plant(e_1) = x $\wedge$ plant(e_2) = y]
$\rightarrow$ plant($e_1 \cup_E e_2$) = $x \cup_I y$]

b. plant($e_1 \cup_E e_2$) = plant(e_1)$\cup_I$plant(e_2)

Assuming that a homomorphism from events to individuals in (60) is the denotation of *plant*, I propose the structure in (64) as the structure of (60). In this structure, the complex predicate MP + μ combines with *plant*, which is of type < e,vt >. Then the denotation of a measure function μ in the verbal domain needs to be modified accordingly. I propose the denotation in (65) for μ associated with internal split MPs. The compositional semantics of (60) is given in (66).

(64)



(65) $[\![\mu_{V'}]\!] = \lambda d_d.\lambda P_{<e,vt>}$: MON(μ, Range$_P$($h$)).$\lambda x_e.\lambda e_v$. P(x)(e) $\wedge$ μ(e) = d

(66) $[\![$*three*-CL + $\mu_{V'}]\!] = \lambda P_{<e,vt>}$:MON(card., Range$_P$($h$)).$\lambda x_e.\lambda e_v$.
P(x)(e) $\wedge$ cardinality (h(e)) = 3 individuals
$[\![$*plant*$]\!] = \lambda x_e.\lambda e_v$. *plant(e) = x
$[\![V']\!] = \lambda x_e.\lambda e_v$.*plant(e) = x $\wedge$ cardinality(h(e)) = 3 individuals
$\exists$ + $[\![NP]\!] = \lambda P_{<e,vt>}.\lambda e_v$. $\exists$x[*tree(x) $\wedge$ P(x)(e)]
$[\![VP]\!] = \lambda e_v$. $\exists$x[*tree(x) $\wedge$ *plant(e) = x $\wedge$ cardinality(h(e))
= 3 individuals]
$[\![Voice']\!] = \lambda y_e.\lambda e_v$. Ag(e) = y $\wedge$ $\exists$x[*tree(x) $\wedge$ *plant(e)
= x $\wedge$ cardinality(h(e)) = 3 individuals]
$[\![VoiceP]\!] = \lambda e_v$. Ag(e) = j $\wedge$ $\exists$x[*tree(x) $\wedge$ *plant(e)
= x $\wedge$ cardinality(h(e)) = 3 individuals]
$[\![TP]\!]$ = 1 iff $\exists e \exists$x[Ag(e) = j $\wedge$ *tree(x) $\wedge$ *plant(e)
= x $\wedge$ cardinality(h(e)) = 3 individuals]
Presupposition: μ: cardinality must be monotonic to the range of h.
Assertion: There is a plural event e of John's planting x and there is x such that x is a tree/trees. μ applied to h(e) yields 3 individuals.

Under the proposed analysis, any thematic function (or a verb meaning due to the absence of the theme function) should be able to serve as a homomorphism h, assuming that all thematic functions are functional and cumulative.

Suppose that there is a planting-a-tree event that consists of three subevents; John dug a hole with a shovel, Mary carried a tree with a cart, and Bill covered the roots with a scoop. Then we can say that the sum of a shovel, a cart, and a scoop is the instruments of the planting event. This example illustrates that the instrument function is cumulative. However, instrument NPs cannot host a split MP, as shown in (67).

(67) *John-ga sono ki-o **syoberu**-de kinoo **mit-tu**
John-NOM that tree-ACC shovel-with yesterday three-CL
ue-ta (koto)
plant-PAST
'John planted the tree with three shovels yesterday.'

What is wrong here is not the lack of a homomorphism, but the lack of c-command relation. As discussed in (41b) above, a split MP must be c-commanded by its host NP. Thus, (67) is out not because the instrument function cannot be a homomorphism, but because the split MP cannot be c-commanded by the host NP *syoberu* 'shovel'. In (67), the host NP is embedded in PP, and thus it is unable to c-command the split MP. Due to this syntactic constraint, split MPs are observed with arguments (agents and themes), but not with adjuncts.

Let us now turn to the second question of how to specify which function serves as a homomorphism h. In particular, we need to make sure that h is the agent function when the host NP is an external argument, and that h is the verb denotation when the host NP is an internal argument. The analysis proposed in Sect. 3.2 requires h from events to individuals, but there is no specification as to which function is involved. For instance, in (68a), the split MP indicates that we need μ: cardinality, which calls for h from events to individuals, yielding the sub-formula cardinality(h(e)) = 2 individuals, as in (68b). However, since it does not specify which function is involved, h from events could be to individuals in the extension of the external argument *sensei* 'teacher' (when h is the agent function) or to individuals in the extension of the internal argument *gakusei* 'student' (when h is the verb denotation). Empirically, only the second option is available for (68a) (cf. Nakanishi in press).

(68) a. **Sensei$_1$**-ga **gakusei$_2$**-o **huta-ri**$_{*1/2}$ nagut-ta (koto)
teather-NOM student-ACC two-CL hit-PAST
'A teacher/teachers hit two students.'

b. $\exists e \exists x \exists y[Ag(e) = x \wedge {*}teacher(x) \wedge {*}student(y) \wedge {*}hit(e) = y$
$\wedge$ cardinality $(h(e)) = 2$ individuals]

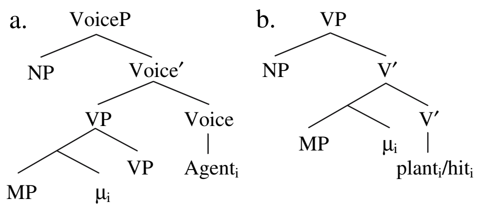
To account for this, the syntactic constraint discussed in 3.1 becomes relevant: the split MP must be c-commanded by the host NP. Based on this constraint and the structures of the split MP construction proposed in (55b) and (64), we might be able to say that the measure function μ associated with the split MP must bear the same index as the closest c-commanding NP and that μ applies to the co-indexed NP. In (68a), for example, the internal argument *gakusei* ‘student’ is the closest c-commanding NP of the split MP, hence μ bears the same index as the internal argument, predicting that μ applies to elements in the denotation of the internal argument. However, this analysis cannot account for (69a), whose denotation is given in (69b). The proposed analysis would predict that μ applies to the denotation of the internal argument *gakusei* ‘student’. But note that in (69a), the denotations of the internal and external arguments are identical, namely, ⟦**student*⟧ (e.g., if the extension of the internal argument is $\{x, y, z, x\cup_I y, x\cup_I z, y\cup_I z, x\cup_I y\cup_I z\}$, then the extension of the external argument is also $\{x, y, z, x\cup_I y, x\cup_I z, y\cup_I z, x\cup_I y\cup_I z\}$). The current analysis would certainly guarantee that μ: cardinality applies to students, that is, for all relevant events e, *h*(e) in cardinality(*h*(e)) is a member of ⟦**student* ⟧ . However, this still allows for ‘two-CL’ in (69a) to be linked to the external argument, yielding the reading ‘two students hit a student/students’. Contrary to this prediction, (69a) lacks such a reading.

(69)a. **Gakusei**$_1$-ga **gakusei**$_2$-o **huta-ri**$_{*1/2}$ nagut-ta (koto)
student-NOM student-ACC two-CL hit-PAST
‘A student/students hit two students.’

b. $\exists e \exists x \exists y[Ag(e) = x \wedge {*}student(x) \wedge {*}student(y) \wedge {*}hit(e) = y$
$\wedge$ cardinality $(h(e)) = 2$ individuals]

Alternatively, I suggest that the measure function μ associated with the split MP must bear the same index as the head taking the closest c-commanding NP as its argument and that the co-indexed head serves as *h*, as schematized in (70). In (55a) with the external split MP, for instance, the closest c-commanding NP for the split MP is the external argument *otokonoko* ‘boy’ and the head taking this NP as its argument is the Voice head dominating the agent function, as in (70a). Thus, the relevant *h* must map from events to agents. In (60) with the internal split MP, the closest c-commanding NP for the split MP is the internal argument *ki* ‘tree’ and the head taking this NP as its argument is the transitive verb *ueru* ‘plant’, as in (70b). It follows that the relevant *h* is the denotation of *plant*. (69b) involves the internal split MP, hence the relevant homomorphism is the denotation of *hit*, as in (70b). Even though the extensions of internal and of external argument *gakusei* ‘student’ are identical, the students y in the range of *hit(e) = y differ from the students x in the range of Agent(e) = x. Thus, the proposed analysis correctly predicts the interpretation in (69b).

(70)



4 Concluding remarks

In this paper, I examined some aspects of the grammar of measurement, appealing to Schwarzschild's (2002) notion of monotonicity. It was argued that, in some constructions, the measure function must obey the monotonicity constraint with respect to the domain of measurement. On the one hand, constructions that measure in the nominal domain, namely, the English pseudopartitive and the Japanese non-split MP construction, are subject to the monotonicity constraint in the nominal domain. On the other hand, there are some constructions that seem to obey the monotonicity constraint in the verbal domain. In particular, I showed that the Japanese split MP construction is subject to some semantic restrictions in the verbal domain (incompatibility with single-occurrence events and with I-level predicates, and (un)availability of collective readings). It was argued that this construction involves the measurement of events, and thus the semantic restrictions are observed in the verbal domain. Furthermore, since the measurement of events requires a mapping from events to individuals, semantic restrictions due to monotonicity are observed in the nominal domain as well.

A very important question for any linguistic analysis is how well it stands up when applied to different languages. One of the issues regarding this point is whether the proposed analysis of non-split and split MP constructions in Japanese applies to corresponding constructions in other languages. It has been argued in Nakanishi (2004a, 2007) that the characteristic semantic properties of non-split and split MP constructions in Japanese observed in this paper also hold for these constructions in German, Greek, and Catalan, suggesting that monotonicity is a universal formal property of measurement constructions. Some relevant examples from German are given below;

(71) **Studenten** haben Peter **drei** {geschlagen / ??umgebracht}.
students have Peter three {hit / kill}
'Three students {hit / killed} Peter.'

(72) **Wildschweine** sind **viele** {verfügbar / *intelligent}.
wild boars are many {available / intelligent}
'As for wild boars, many are {available / *intelligent}.' (Diesing 1992: 40)

(73) **Jungen** haben **drei** ein Modellboot gebaut.
boys have three a model boat built
'Three boys built a model boat.' √distributive, ??collective

Another cross-linguistic issue is whether there are other constructions to which the proposed analysis (or parts of it) can be extended. In Lasersohn's (1995) work on pluractional markers (morphemes that mark the plurality of actions), it has been proposed that there is a homomorphism *h* from events to other domains and that, depending on which *h* is chosen, plurality is interpreted in terms of places, times, etc. Similarly, Nakanishi and Romero (2004) argue that *for the most part* in English quantifies over events and that events can be mapped to some other domain by a homomorphism. This enables us to account for a wide range of interpretations obtained with *for the most part* (e.g., *for the most part, John likes his colleagues*; *for the most part, I slept*, etc.). Furthermore, Nakanishi (2004b) observes two types of comparative constructions in English and Japanese, one involving the measurement of individuals and the other involving the measurement of events with a homomorphism. These comparative constructions are subject to some restrictions in the nominal domain and/or in the verbal domain that can be explained by monotonicity.

I hope to have shown in this paper that the proposed analysis, which makes use of the notions of monotonicity and a homomorphism, provides us with an adequate tool to account for the grammar of the different measurement constructions.

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